
MACHINE DESIGN
September 1952
(LIBRARY)
The Engineering Library
By RANDOLPH W. CHAFFEE
Why and how the technical library should be set up and utilized in creative engineering.
ENGINEERING MANAGEMENT
SEP 15 1952

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MACHINE DESIGN

SEPTEMBER 1952, Vol. 24—No. 9

THE PROFESSIONAL JOURNAL FOR CHIEF ENGINEERS AND DESIGNERS

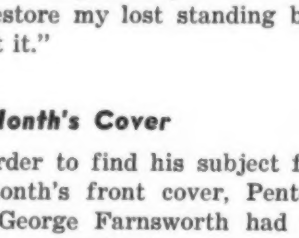
Over the Board

Keeping Up with the Younger Set

Our contributor who told about the No-Detail Chief last month (in Stress Relief, Page 260) writes: "Will appreciate your sending me tear sheets of the original Detail Engineer (May issue, Page 210) as well as the No-Detail Chief. For a number of years I had had my red-headed young daughter suitably impressed with my literary abilities, having told her about writing a strip—sometimes loosely referred to as a humor column—for a small but discriminating section of the readers of the weekly paper while I was in college. She was no longer impressed when at age ten she broke into *The New Yorker,* an event which I have not been allowed to forget. Maybe this will help restore my lost standing but I doubt it."

This Month's Cover

In order to find his subject for this month's front cover, Penton artist George Farnsworth had to make an excursion into the future. We are happy to report that his time machine functioned smoothly and that he had no trouble locating a modern engineering library where, by the happiest of coincidences, someone was just in the act of inspecting the catalog card for this month's lead article. Since this was back in July it must have given George "quite a turn" to see a copy of the September issue of MACHINE DESIGN lying on top of the file cabinet.



Electric Motors

Ever try to figure out how many electric motors you have around home? Make a guess and then start counting to see how close you came. One of our editors who tried it was amazed to discover how much he had underestimated the number. By actual count he found 28 motors, from the attic fan to the basement workshop and not forgetting the clocks, vacuum cleaners, record players, electric razors, etc.

And that's only the 115-volt stuff. Going out into the garage he found a flock of 6-volt motors including starter, blower, defroster and top-raising motors. Knowledge that it was the readers of MACHINE DESIGN who put all these motors there gives us a personal interest in them.

Good Luck, Jack!

We are sure that the many friends of John W. Greve, who is leaving the editorial staff of MACHINE DESIGN to become Editor of *The Tool Engineer,* official journal of the American Society of Tool Engineers, will want to join us in wishing him well in his important new job. Jack's picture and a short biography appear on Page 208 of this issue. Readers will recall his "best-selling" article on Electric Motors which was the principal feature of the April issue this year.

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ITEMIZED INDEX

Classified for convenience when studying specific design problems

MACHINE DESIGN is indexed in Industrial Arts and Engineering Index Service, both available in libraries generally.

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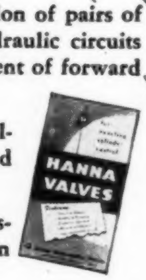

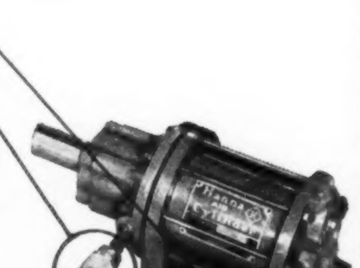

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HYDRAULIC AND PNEUMATIC EQUIPMENT...CYLINDERS...VALVES...RIVETERS

Mobilizing for Creative Engineering

IN THEIR EFFORTS to exploit the scientific and engineering wisdom of the West, the Communists have been known to engage in elaborate espionage to obtain information that is readily available in published form for all to read. Because they get it the hard way perhaps they set greater store by such information than do we who have at our disposal a vast storehouse of knowledge printed in our own language. This raises the question, do we really appreciate the tremendous resources that are waiting to be tapped in scientific and engineering literature?

It is a safe bet that many of today's engineering "flops" could have been avoided if their designers had taken time to study scientific principles and factual data available in books and periodicals. By the same token, many of today's best designs undoubtedly incorporate knowledge and experience gleaned from the same publications.

We don't for a moment suggest that good engineering consists of copying the work of others, a la Russians. Kettering has said that reading a book is no way to solve a problem "because any time that you don't want to do a thing I can get you a book that will tell you it can't be done." But he goes on to say that "you should set up your problem, think it out, decide how it ought to be done, *then* go and see what has already been done on it." Thereby without stifling creative thinking we establish guideposts that will help us avoid roadblocks and blind alleys.

To get the most out of the limited supply of engineers and to achieve maximum efficiency in engineering through effective use of published information requires a positive approach. Essential steps include these:

1. Establish and maintain a comprehensive library of engineering books and periodicals under the supervision of a competent librarian.

2. Develop the proper use of the library as an integral part of the engineering effort.

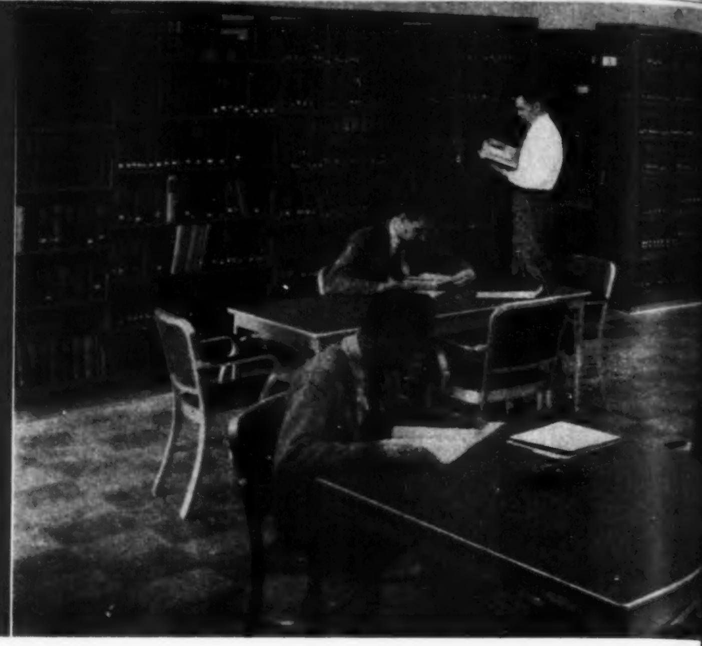
3. Instill in the minds of the design engineers a proper attitude and philosophy toward the use of books and periodicals as an aid to creative engineering.

Far-seeing engineering executives already have found that such a program pays big dividends. It is a vital part of the total mobilization of available resources for the creation of effective engineering designs.

Colin Carmichael

EDITOR

MANY GOOD AND SOUND REASONS exist for the individual special engineering library, but these too often are either ignored or unrecognized. Randolph Chaffee, the author of previous articles on engineering department management, has made an exhaustive study into this area and here places on record poignant and emphatic proof of the outstanding value of the special library, how best it should be planned, and how it can be evaluated most effectively



THE ENGINEERING LI

By Randolph W. Chaffee
Management Consultant
Strong-Narovec and Company
Cleveland, Ohio

CREATIVE engineers or designers are the first to agree with the old adage—"There is nothing new under the sun." The atomic bomb burst upon the public consciousness for the first time only a very few years ago, as a brand-new form of science. Nonetheless, physicists have known for many years, not only in the USA but also in several other countries including Germany, Italy and Russia, the underlying theory of nuclear fission. What was new about the atomic bomb was the adaptation of known practical arts to the problem of controlling nuclear fission

Creative engineering invariably requiries reference into the literature but space for individual reference works is seldom available or adequate

Charles Cross Goodrich Memorial Library in the new B. F. Goodrich Research Center, Brecksville, Ohio. This 10,000 volume library, containing an outstanding collection of literature relating to rubber, is housed in an area of about 3500 square feet with separate work room, microfilm room, and patent storage room. The magazine racks have adjustable sloping and flat shelves for flexibility in storing current periodicals until they are bound

ARY

Why and how the technical library should be set up and utilized in creative engineering

and of directing the phenomenon toward a specific objective.

Thus to a large degree invention has become, not the creation of new art, but the adaptation of old art to new purposes. We begin the creative process by learning of man's achievement to date, and we proceed by molding or re-directing his methods to our contemporary objectives.

How do we learn of man's achievements? How do we pick up where he left off and go on from there, avoiding needless duplication of past effort? To begin with, how do we locate the source of intelligence and then draw from that source the pertinent information we need?

The source of all knowledge is the record, a little of which is locked up in the minds of the living and much of which is written down for all to read. When any appreciable volume of this record is gathered together in one place, a library has come into being. When the knowledge contained in the record has been organized for quick reference to the advantage of many, then the library has become a living, dynamic and constructive influence which conserves the resources and multiplies the effectiveness of those it serves.

Americans brag, and with just cause, of the relatively tremendous mechanical horsepower which backs up every workman in our industries. The workman's individual strength and skills are extended and multiplied something like 15,000 times by the tools he uses, as compared with less than one-half that amount in other industrialized nations of the world. Who will undertake to measure the astronomical projection of man's creative powers which is supplied by the unfettered circulation of technical knowledge from our libraries? It is beyond human comprehension.

Until the recent years of accelerated blossoming of specialized purpose in industry, the management of the storehouses of recorded knowledge has been confined largely to our public libraries. Operated by highly-trained and devoted practitioners of library science under severe handicaps of limited resources, public librarians have nevertheless nearly achieved the impossible task of bridging the gap between demand for technical knowledge and their supplies of this knowledge. When one considers the great many fields of new scientific application, it is not surprising that the endeavors of the public libraries require supplementing by "special" libraries in the technical fields.

Along with the growth of "special" or "corporation" libraries, industry is leaning with increasing weight upon the resources of public libraries and their science-technology departments. This is the inevitable

Research library of the Caterpillar Tractor Co.

result of the broad coverage offered by those facilities. However, it behooves industry to concern itself with public library budgets, to assure that our public libraries receive their just portion of municipal funds, and that those departments of public libraries which serve industry are given the resources needed to accomplish that service.

How the Library Aids the Enterprise

The Special Library: When a library operation focuses its attention on, and serves a limited area of interest, it becomes a Special Library and its resources and usefulness become highly accentuated in that area. According to the Special Libraries Association, the more prevalent categories among the 2500 special libraries in the United States are as follows:

1. Biological science, including agriculture, biology, botany, dentistry, food, hospitals, medicine, public health and zoology
2. Business, including advertising agencies, chambers of commerce, retail stores, trade and business associations, and the business economics branches of public libraries
3. Finance, including banks and trust companies, brokerage houses, statistical organizations and other financial establishments
4. Insurance, including libraries serving home offices, field representatives and clientele
5. Museum, including art, natural history, natural science and historical societies
6. Newspaper and publishing, including "morgues" of information on people and events
7. Science-technology, including research and production in chemistry, communications, aviation, public utilities, engineering in all its branches, petroleum, rubber, textiles and allied subjects, and science and/or technology departments in public libraries
8. Social science, including education, foreign relations, labor organizations, law firms, religious and social service organizations, and institutions.

For the purpose of this article, the field of science-technology will be used to discuss the value of the special library to creative engineering and machine design.

When a special library is identified with a scientific or technological endeavor, it becomes known as a Technical Research Library and these terms convey a special meaning with primary emphasis upon research. In addition to containing knowledge and making that knowledge available within its original covers upon request, the special library engages in active search, selection, interpretation, assembly and presentation of related facts from all sources for the purpose of making a creative contribution to a specific problem. This contribution represents a whole and integrated step which precedes and enables the creative work to be started.

To illustrate this distinctive feature of the special

Modern library facilities of the A. O. Smith Corp.

library, an early step in the design of a new automatic screw machine of a given size and type is the search, selection, interpretation, assembly, and presentation of related facts from all sources comprising the whole art of automatic screw machines of the given size and type to date. This presentation provides the "springboard" from which the creative design project takes off to develop the practical advancement and improvement in automatic screw machine design. The special or technical library staff selects the information on automatic screw machines from various sources; reviews this information to screen out that which obviously is irrelevant; classifies, arranges and assembles the selected information in an orderly manner; and prepares the findings into a useful reference presentation.

Technical libraries usually are owned by engineering or manufacturing enterprises, housed on company property and operated by employees on the company's payroll who have no other duties than to make that library operation serve the company to maximum advantage.

In the minds of many, there are two different types of special library to be found within one company. One is the company library which is designed to serve the whole company organization generally, without limitation to the company's industry, products or operations. Such a library provides entertainment reading for the employees, it collects general information for executives' speeches, it preserves the history of the company's growth, and it performs a range of services aimed at public relations, employee-relations and other broad social objectives.

Distinct from this, at least in the larger companies, is the technical special library which is designed to serve the company's requirements for information pertaining to operative and creative technology, whether in the law, finance, production, sales, or engineering functions.

Being more directly justified on purely economic grounds, the technical special library is the heart and core of library service in the smaller companies, where it becomes a vital and integral part of the engineering or other technological resources. However, there is no good reason to sustain an arbitrary distinction from the company library functions or to deny the technical library a right to serve the whole organization in any constructive way that it can. In fact, one of the technical library's most effective devices for interpreting its services and usefulness and attracting clientele interest and support is its nontechnical aids and resources.

In this discussion the company technical library operations to be considered will be those not only having primary responsibility for contributing to the technical program, but also having latitude for rendering useful library services to the company organization as a whole.

Why the Library Is Found Essential

Scope of the Technical Record: It is not within the purpose of this article to describe the whole vast scope of the technical record as it appears in the 2400 special libraries in the country, and as it is available to each of them through exchange. The resources of these special libraries are crystallized with brief descriptive notes and statistical data in a publication

Table 1—Available Technical and Trade Periodicals

Agriculture

Farm Implements & Tractors	12
Landscape Gardening & Parks	5
Seed & Nursery Trade	7
	24

Construction

Air Conditioning	20
Architecture	19
Construction, Contracting, Building & Excavating	82
Plumbing & Heating	33
Roads & Streets	17
	171

Food Preparation & Processing

Baking	14
Beverages, Brewing & Bottling	77
Canning, Packing & Dehydration	8
Confectionery, Ice Cream & Soda Fountains	21
Frozen Food	7
Grocery & Delicatessen	74
Meats & Provisions	16
Milk & Milk Products	26
Sugar & Sugar Beet	7
	250

Engineering

General, Mechanical, Electrical, Civil, etc.	127
Nuclear	2
	129

Marine

Boats	9
Marine, Shipping & Shipbuilding	30
	39

Manufactures

Boxes, Barrels & Containers	17
Brick, Tile, Cement & Concrete	12
Brooms, Brushes & Mops	2
Canvas Goods	1
Ceramics	7
Cordage & Twine	1
Cosmetics & Toiletries	8
Curtains, Draperies & Housefurnishing Goods	7
Electrical Products	37
Explosives	1
Firearms	3
Furniture, Rugs, Carpets & Upholstery	24
Gifts, Toys & Novelties	8
Glass & China	9
Hardware & Sporting Goods	19
Harness & Saddlery	1
Jewelry & Watchmaking	12
Knit Goods	7
Lighting & Lighting Fixtures	5
Machinery	18
Metal Working & Metal Trade	50
Motion Picture Industry	26
Music & Musical Instruments	37
Notions	2
Oils, Fats, Animal & Vegetable	5
Optical & Optometry	10
Paint, Painting & Decorating	19
Paper	20
Plastic & Composition Materials	6
Printing & Typographic	39
Roofing	4
Rubber Stamps, Seals & Stencils	2
Sheet Metal Working	4
Shoes, Leather & Luggage	18
Stationery & Office Supplies and Equipment	10
Textiles	23
Tobacco	16
Venetian Blinds	3
Weights & Measures	3
	496

Products of Natural Resources

Coal & Coke	15
Lumber, Building Materials & Woodworking	42
Mining & Materials	24
Petroleum, Oil & Gas	55
Stone & Rock Products	5
	141

Not Otherwise Classified

Military & Naval	49
Photography	19
Power & Power Plants	17
Public Utilities	5
Radio & Television	44
Refrigeration	13
Telephone & Telegraph	24
	171

Health & Safety

Dental	28
Firefighting & Protection	8
Hospitals & Nursing	24
Medical & Surgical	207
Physical Education & Athletics	10
Veterinary	6
Water Works, Wells & Sewerage	8
	296

Transportation

Aviation	35
Automotive Trade	53
Bicycle & Motorcycle	8
Motor Bus & Taxicab	9
Motor Trucks	38
Railroad	54
	197

Services

Amusements	22
Barber & Beauty Shops	9
Hotels, Restaurants, Clubs & Tourist Courts	74
Laundry, Dry Cleaning & Dyeing	18
	123

Sciences

Chemistry	29
Mathematics	12
Physics	9
Scientific, General	28
	78

Distribution

Advertising & Marketing	30
Vending Machines	6
Warehousing	3
Window Display	3
	42

Recapitulation

Agriculture	24
Construction	171
Distribution	42
Engineering	129
Food Preparation & Processing	250
Health & Safety	296
Manufactures	496
Marine	39
Products of Natural Resources	141
Sciences	78
Services	123
Transportation	197
Not otherwise classified	171
	2157

of the Special Libraries Association, titled "Special Library Resources."

However, one interesting clue to the scope of the technical record is a classified subject list of the regularly published technical and trade periodicals which appears in TABLE 1. This list of 2157 such periodicals by major and minor subject classifications reflects the array of recorded experience and opinion which is available. This list of course, is incomplete insofar as going periodicals are discontinued, merged or renamed. Too, some of the publications included are regional in character, being addressed to readers primarily in one geographical section of the country, and are duplicated in some measure by like publications addressed to readers in another geographical section.

Reaching Into The Vast Record

Setting Up a Technical Library: A natural question for the senior executive to ask himself is . . . "How do I go about setting up (or modernizing) a technical library in our company?" There are several answers to this question and the trick is to pick the $64.00 one.

One way is not to go about it. Just do nothing at

all and a technical library will come into existence, willy-nilly, sometime, in response to the inevitable pressure of demand for it. The individual staff members will buy or subscribe to the books and periodicals which interest them, and these will be exchanged among those individuals on their own initiative. Sooner or later, someone will leave a book or periodical with a file clerk saying . . . "Joe wants to borrow this so will you see that he gets it when he comes in?" At that moment, that file clerk has become a "librarian" of sorts, and begins to engage in the circulation of library materials, and from there on, the activity grows slowly. This method has the questionable virtue of being cheap and easy but the whole thing certainly drags its feet all the way up.

Second answer is almost as cheap and easy and that is to designate a file clerk to set up and run the so-called library. Possibly some of the boys will loan some of their own books to the library and also turn over their magazines when they get through with them, and Sadie the file clerk can sort of pass them around in her spare time. About the only good this method does is to get Sadie a raise and a sign on her desk reading LIBRARIAN.

It would be nice if all who wished could hire trained and experienced information-research people to set up and operate technical libraries. As it happens, not enough people have been attracted to this work in the past and the present supply is somewhat limited.

It is only natural for a company to call in a public accountant to set up or revise a set of account books and to supply training for bookkeepers, on a temporary or intermittent professional basis. So may the qualified expert be called in to supply counsel and guidance in setting up or modernizing a technical library. In a series of visits spread over a period of time and devoted to laying out programs of development, checking progress of information-research trainees, and assuming responsibility for accomplishing the company's objectives, the consultant can supply a practical solution to the problem of setting up or modernizing a technical library.

In this respect the following statement by the Executive Secretary of the Special Libraries Association may be useful:

> "Special Libraries Association has always offered assistance in organizing or reorganizing special libraries. We do have available some free material on organizing a library, layout of space, and so forth. Several of our members, who have had considerable library experience but who do not wish to be employed full time, do act as consultants.
>
> "A free placement service is maintained by SLA for members and employers. Most of the calls, of course, are for librarians or assistant librarians but we have in the past, been instrumental in furnishing consultants for several concerns contemplating library reorganizations."

The highly developed "know-how" of the doctor with experience in industrial medicine, is required to set up and operate the company hospital. The same degree of training and experience is required to set up and take the responsibility for the company technical library. And the company management must expect to give both the same unqualified support and confidence.

One fact which is not obvious to the layman, is that the technical library does not attempt and does not need to possess all of the recorded information which it uses. With a properly set up and manned library, a tremendous wealth of technical information is placed on ready tap. Through interchange with

Extensive engineering operations today demand ready reference to all literature pertinent to the area involved

Photo, courtesy Boeing Airplane Co.

public and other company libraries, the technical library employs its knowledge of sources to reach outside of its own four walls for information, and a large part of its value lies in knowing just where and in what direction to reach. Means have been found to speed up the transmission as well as the storage of information, and these are applicable to practically all library services, large or small.

Almost any part of the record of a library can be reproduced in miniature on a small Library Bureau file card containing the equivalent of many printed book pages so that a few of these cards carry as much data and information as an entire textbook. These Microcards, produced under the sponsorship of the Microcard Foundation of Middletown, Connecticut, are enlarged to normal size for reading in a device called the Microcard Reader. A Microcard file can contain a large bulk of a library record in a tiry space.

Full-size Microcards in the standard size are 7½ by 12½ cm and contain as many as 60 pages of regular-size book text as shown in the accompanying illustration. For reading, the miniature images are enlarged by 24-power magnification and projected in normal size on a screen. As of December, 1950, eighteen companies, societies, universities and individuals had become authorized publishers of Microcards in eleven cities from Boston in the East to Tulsa in the West, and from Louisville, Ky. in the South to Chicago and Schenectady, N. Y. in the North. The United States Navy now publishes all technical project reports on Microcards. Eastman Kodak Company has the next largest installation where research literature has been Microcarded for the last three years. This system appears to offer to the company technical library a fast and inexpensive means for acquiring a selected mass of information, not otherwise readily available.

Another possibility is electrical facsimile transmission by wire, and photographic reproduction of the image received. Any public or other library equipped with a facsimile transmitter could serve a large number of companies equipped with facsimile receivers. A relative newcomer but highly promising in the field of intelligence transmission is the Vericon wired-television system which transmits the moving as well as static image. This system allows the distant viewers to witness the details of moving machinery, a surgical operation, an explosion and other phenomena as they occur. Presumably, the system could be employed over a distance for the searching of the record at will.

In addition to these new methods, there are other devices such as Microfilm which are particularly suited to a company technical library. These devices, however, are fully described in the literature and need not be described again here. The "know-how" of the competent technician entrusted with the task of setting up or modernizing a technical library encompasses knowledge of and experience with all such devices.

Undoubtedly, there are practical deterrents to special subsidized encouragement of public library technological departments but it is probable that American inventive genius can overcome them as easily as it has overcome the problem of immediate and rapid transmission of recorded intelligence. It appears that industry might do itself a large favor in giving serious consideration to sponsoring, assisting and accelerating the technical services of public libraries.

An Answer To The Engineer Shortage

Utilization of the Technical Library: The outstanding virtue of the technical library is its ability to spare the technician from taking time away from his primary creative work for the purpose of searching the record for the information he requires. With a technical library staff at his elbow to find and produce the information he wants and when he wants it, the engineer can give all of his time, without distraction

Reproduction of 3 by 5 inch Microcard containing 60 periodical pages on phys

THE ENGINEERING LIBRARY

to his creative work and he becomes far more effective thereby. To a large degree, the engineer does not even have to specify what information he wants when he knows that his library is constantly watching out for information related to his project and will bring it to his attention in the normal course of that library operation. Still more important, the engineer is confident that his library will bring to his attention pertinent information which he would not know is available, and which probably he would otherwise miss.

In the article, "Need Engineers? Help Yourself," published in *Steel,* October 22, 1951, E. C. Birkner points out that the acute shortage of engineers results in large measure from the employment of engineers on tasks that others could perform equally well for them. He quotes Henry H. Armsby, associate chief of engineering education in the Federal Security Agency . . . "an increase in the efficiency or productivity of only 10 per cent among engineers would be equivalent to adding to our labor force about 40,000 engineers." Insofar as engineers are now engaged partly in library research work, there is an untapped reservoir of engineering manpower to be released by the fuller utilization of technical library services.

One interesting clue to the limited use being made by industry of technical library science may be found in the readers' response to this author's article, "Evaluating Engineers", in the June, 1951, issue of MACHINE DESIGN. At one point in the process of fulfilling requests for reprints of this article, the publishers had received requests for 2200 copies—which later grew to 4000—over the signatures of the whole range of title-holders from engineers-in-training and draftsmen to presidents, partners and owners of engineering and industrial enterprises. Only 52 or 2.4 per cent of these requests came from technical libraries, and the remaining 2150 reflect librarian work being performed by nonlibrarians at the expense of their normal duties. As many as 31 copies were requested by different individuals in the same company at the same address, and there were several hundred companies in which several individuals made independent requests.

One question frequently asked is, "How far does the information-research librarian go in digging out and interpreting information requested?" In an effort to supply some part of the answer to this question, the author requested the practicing special librarians of several representative companies to cite typical assignments which they had completed. These assignments are indicated by the following:

1. Develop a digest of engineering administration in the aircraft manufacturing industry.
2. How does the Schlieren interferometer work?
3. What are the precedents for marketing capital goods by rental?
4. What are the essential principles for diversification of industry?
5. How are ultrasonics used in metal treating?
6. Prepare a digest of the experience with hydraulic couplings on machine tools.
7. What are the distinctive purposes and features of the Cyclone coal burner?
8. How are engineering drawings transferred directly to metal sheets and plates?
9. What level of lighting intensity is recommended for the most complex mechanical drafting?
10. What is meant by "octane" as applied to petroleum products and how is it calculated?
11. Assemble geophysical profiles indicating pressure and density of minerals.
12. What is the correct rate of armor-plate cooling to avoid brittleness?
13. What are the comparative vibration-damping characteristics of felt, coil springs and semicured rubber?
14. Prepare a list of reference texts on torsion springing.
15. What is the status of the program for harmonizing British and American screw thread standards?

When we say here that the technical information-research staff completed the assignments indicated above, we do not imply that the staff made the final selection or came up with the one best answer in all cases, solely upon their own initiative. Obviously, only the creative technician can make the final selections and produce the final answers. What we do mean is that the information-research staff reviewed all of the available pertinent data and information, culled that which was irrelevant to the specific project at hand, organized and correlated the "meat" of the subject, and presented a well-organized digest.

It will be noted that these typical assignments relate to recorded facts rather than the technological judgments of the library staff. However, the completion of these assignments did require a practical familiarity with the technologies involved, and particularly the special training of locating, amassing, evaluating, classifying, correlating, and producing pertinent information of a technical character. The assignments required screening of information in the sense of discarding that which obviously was impertinent, but not in the sense of making final selections from the pertinent. They required the abstracting of information in the sense of assembling information items under logical classifications, but not in the sense of making technical interpretations.

Where utilized to the maximum advantage, the technical library is an integrated faction of the employee-training program. Under policies and subject matter prescribed by the training director, the technical library staff selects, obtains and circulates textbooks, periodicals and other printed material to the employee-trainees' home study and spare-time reading. The well-equipped library contains comfortable furniture and an attractive environment which draws-in employees and stimulates their interest in the library services.

Many libraries perform personal services for the companies' employees in such ways as obtaining travel folders and information for vacation-planning, obtaining reading material for entertainment and relaxation, and securing answers to questions not closely related to the company's projects.

In other words, the library function can also be a

useful and constructive influence in employee-relations, while stimulating the mental powers of the staff and making them more broadly effective in their work.

Assessing the Library's Real Value

Economics of the Technical Library: So far as is known to the author, no one has compiled conclusive statistics to show that a technical library has saved money or how much. Also, it is not known specifically how many hours of engineering time have been saved on technical information research by library people. However, we can cite some enlightened opinion on the subject. M. J. Voight, librarian, Carnegie Institute of Technology, writes in *Progress Thru Research* (General Mills, Inc.) for Winter, 1948:

> "The research library can be a profit-making institution. It won't bring streams of silver dollars into the till; it won't play a symphony on the cash register; it won't run up a direct surplus on the balance sheet. But it will cut precious hours, weeks, even years from research programs, and it may stimulate one idea that will put millions of dollars worth of black ink in the ledger."
>
> "If the library increases the efficiency of the staff by only one per cent, it will pay for itself . . ."
>
> "A few minutes of the researcher's time in a well-planned library may prove the equivalent of many hours over the drafting board or at the laboratory bench."

It has been found that the typical operating cost of a technical library is about $200 per year per technician served, although this figure would be higher in the smaller organization, and somewhat lower in the larger organizations. This cost represents about 5 per cent of the average salary cost of technicians, designers and engineers, and it takes little imagination to conclude that an efficient technical library is an excellent investment which more than pays for itself.

Information supplied by members of technical library staffs of several companies in various industries indicates a typical annual budget as follows:

Salaries:	
Information-research director	$ 5,500
Information-research assistant A (cataloger)	3,500
Information-research assistant B	2,700
General clerk A	2,300
General clerk B	2,000
Clerk-typist	1,800
Subtotal, Salaries	$17,800
Acquisitions; books, periodicals, reference services, etc.	1,250
Telephone and telegraph	100
Supplies	100
Insurance	50
Memberships in societies	300
Travel and subsistence	300
Other unclassified expense	100
Total annual budget	$20,000

This group of six information-research people can serve a group numbering up to 250 scientists and engineers whose aggregate salaries would be in the order of 2 million dollars. Evidently Mr. Voight was on firm ground in his statement that a 1 per cent increase in the efficiency of the staff pays for the technical library. In actual practice, the saving probably is nearer 15 per cent and the cost returns a saving of 1500 per cent.

Apart from the obvious savings made by the technical library are the intangible losses incurred where a library service does not exist. Anne L. Nicholson, Librarian for the Pennsylvania Salt Mfg. Co., writes:

> "A staffed information library, headed by an inquisitive and technically informed person who reads the current literature and is kept informed of the current engineering project needs, can have on hand before it is asked for, and can circulate as soon as he gets it, literature information which the project engineer can use. And often the engineer, too busy to keep up with every page of every new technical magazine, does not know it exists to help him."
>
> "Also the positive side in the productivity time saved by the engineer who has a special library to file and cross reference the large amount of technical sales literature he receives. Since the man-hour costs of the library staff handling that literature are less than the engineers' man-hour costs, his organization saves money by having the latter's man-hours more concentrated on money-creating productivity."

It may be pointed out, additionally, that the trained technical-information researcher performs the various library functions more efficiently than the engineer and the savings in hourly pay-rates is augmented by the savings in hours expended. That the technical library is a money-saving device is attested by the results of a recent survey by the Science-Technology Division of Special Libraries Association. In reply to 1400 questionnaires, 574 returns showed the following range of salaries paid to the heads of the technical information-research function:

Annual Salary Level	Returns (%)	Accumulative (%)
$9500	1	1
8000	2	3
7500	1	4
7000	2	6
6500	4	10
6000	4	14
5500	3	17
5000	9	26
4500	17	43
(4400)	(Average)	
4000	15	58
3500	18	76
3000	15	91
2500	7	98
Less than 2500	2	100

These organizations would not pay an average salary of $4400 if they were not convinced that the expenditure yields a substantial profit to their com-

panies. The median salaries of $4500 to $4999 were paid in Government libraries in the Border Region which includes Washington, D. C. The second highest median salaries of $4000 to $4499 were paid by industry in all other regions except the New England and Mountain States and Canada.

As an interesting sidelight, this survey also showed the spread in size of library staffs, as follows:

Library Staff (No.)	Returns	Per Cent
1	78	24
2-5	163	50
6-10	35	11
11-25	33	10
26-100	7	2
Over 100	3	1
No response	6	2
Total	325	100

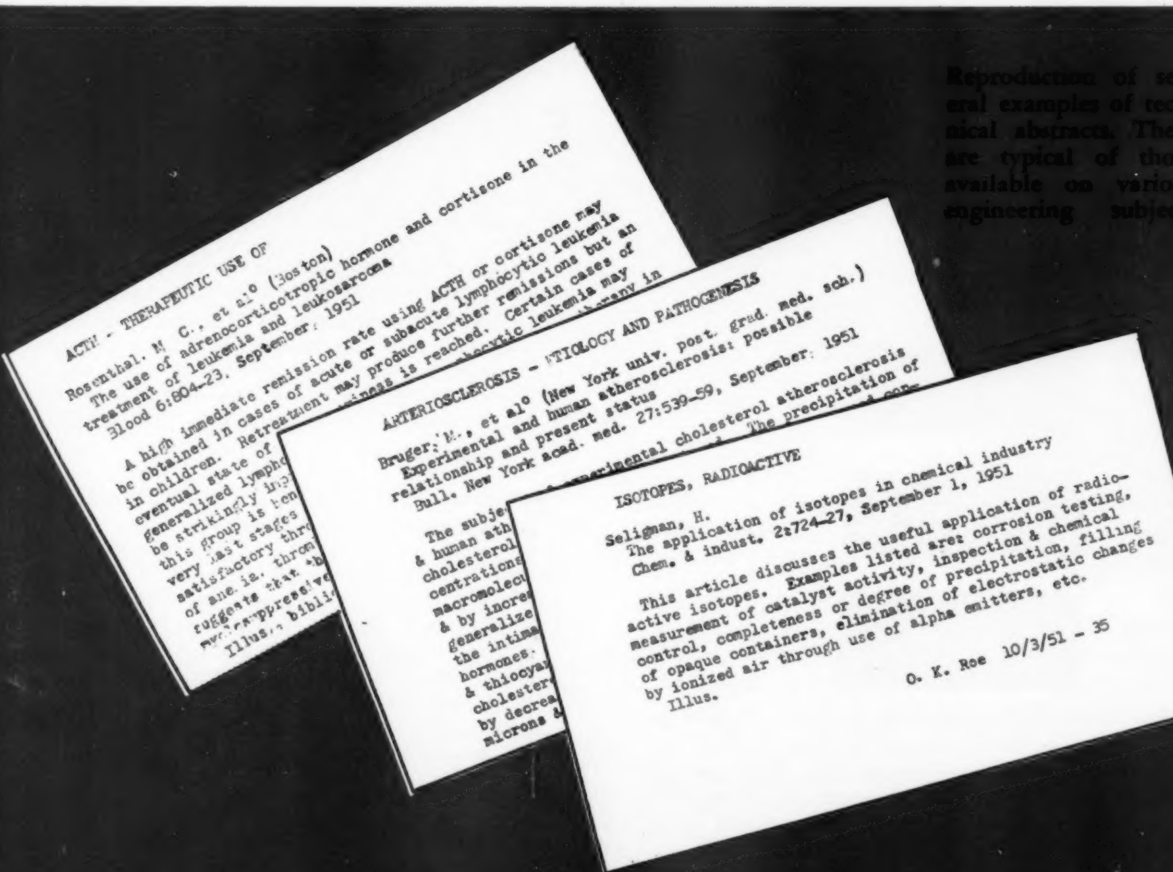
It is evident from these data that the technical library function has had a good start as an integral part of important industrial and related activities and that the function has won recognition as meriting substantial monetary reward for its work.

Setup and Operation

Organization for Technical-Information Research: The purpose and behavior of the technical library can be recognized clearly only if its departure from the traditional concept of library procedure is understood. In the traditional concept, the library is a storehouse of recorded knowledge. It is operated by people trained to acquire, catalog, classify and make this knowledge available to other people who want it. The library operators are concerned with the knowledge contained within their books primarily to the extent required to accomplish that end. They do not use that knowledge for the purposes for which that knowledge was published—their readers do that.

In addition to being a storehouse of selected recorded knowledge, the technical library staff performs the information-research function. Personnel of the technical library use the contents of the record, perform research of the record and locate, select and digest information related to specialized technical requirements. Applying this modern concept of library science, the larger metropolitan public libraries are becoming groups of departmentalized special libraries in which each department is a special library with its staff trained to perform information-research within the department's range of subject matter. This trend is found also in the teachings of library-science schools.

This distinction between, and combination of the operative and research functions is illustrated in the accompanying organization chart. On this chart, the three clerical jobs reading from the bottom up, are clerk-typist, general clerk B and general clerk A. The progression divides above this point between the op-

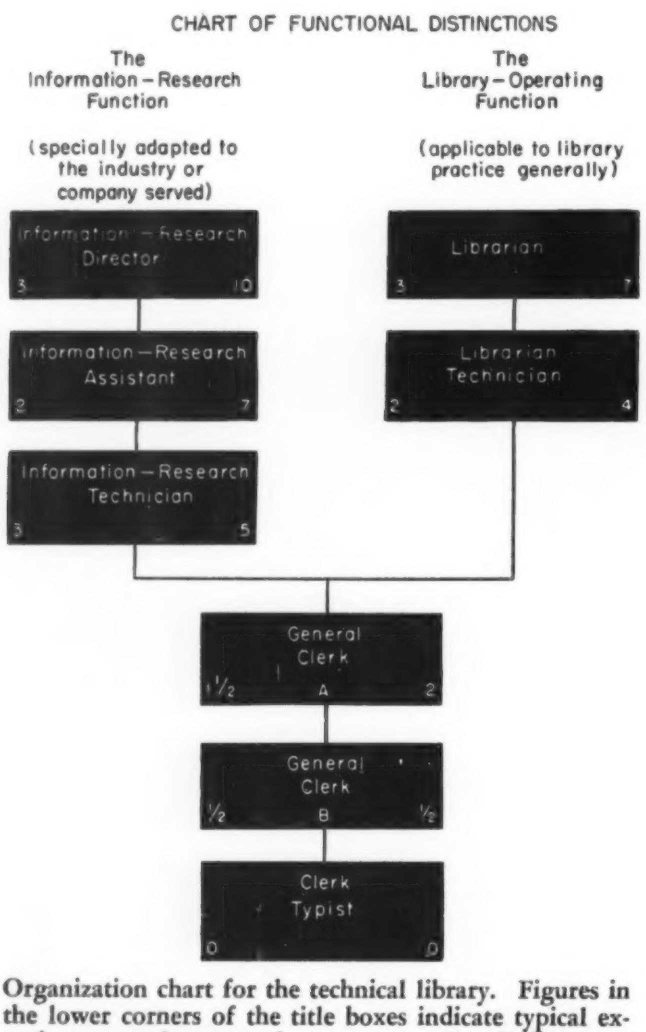


Reproduction of several examples of technical abstracts. These are typical of those available on various engineering subjects

erative function and the research function. In the former division, the operative function is carried into the higher jobs of library technician and librarian, neither of which demands any more intimate knowledge of the industry with which the library is connected than would be gained incidentally through continued association with the library operation.

Specialized technical knowledge is required in the research division and to an increasing degree, in the three jobs of information-research technician, information-research assistant and information-research director. The author believes that this functional distinction merits recognition in the information-research titles noted.

This chart is not patterned after any known technical library, nor does it attempt to suggest any titles or sequence of titles. It is presented for the sole purpose of emphasizing the distinction between the function of library-operation as it is usually understood, and the function of information-research as it is performed by people qualified to serve various engineering program and information needs.



Organization chart for the technical library. Figures in the lower corners of the title boxes indicate typical experience requirements for entrance: (1) Left corner is the number of years in the next lower job or equivalent; and (2) right corner shows total combined years in all lower jobs or the equivalent

A file clerk having no accredited training in library science is not a librarian. Likewise, a trained librarian cannot become proficient in specialized technical-information research until she has acquired a working knowledge of that special technology. The duties and qualifications cited hereinafter, and the resultant evaluation of the information research director, are based upon this viewpoint.

Like the practice of medicine, the creation of a work of art or creative engineering itself, the research of technical information is a highly specialized product of individual talent. It cannot be supervised closely by the uninformed and if so directed, becomes thwarted, frustrated and ineffectual. Like all other professional endeavor, technical information research must have the right to be self-motivating and self-governing. The profession is winning that right by governing itself wisely, by insisting upon adherence to the highest standards of behavior and performance, and by informing industry of its potential value.

Duties of the Information-Research Director: Importance of the technical library may be measured in terms of the duties, prerogatives and responsibilities of the individual charged with the direction of the library, and which are required if the library is to yield the best results. In the technical library of a creative engineering organization, some part of each of the following duties must be performed although the degree of each will vary with the size of the individual library, and with the variety of its contents.

Scope of Duties: In general terms, the important elements of responsibility, supervision received and given, and the overall purpose of the position can be summarized as in the following paragraph:

> Assumes responsibility for the operation and maintenance of the company's technical research library; formulates, recommends and carries out approved library practices and procedures within the limits of the company's budget; directs one or more employees of lower classification and undertakes practices calculated to render maximum information service to the company's staff.

These duties of the technical library director fall into two general categories, namely:

1. Duties demanding the highest order of experience, training and developed powers of resourcefulness, analysis and the like, and which only the Director alone is capable of carrying out
2. Duties related to the direction, instruction, guidance and assistance of the library employees of lower classification, and including the supervision of the routine administrative work of the library.

Information Sources: This area can be defined generally as in the following:

> Taking the initiative in keeping informed of currently published technical information related to the

CONTENTS OF JOB GRADES

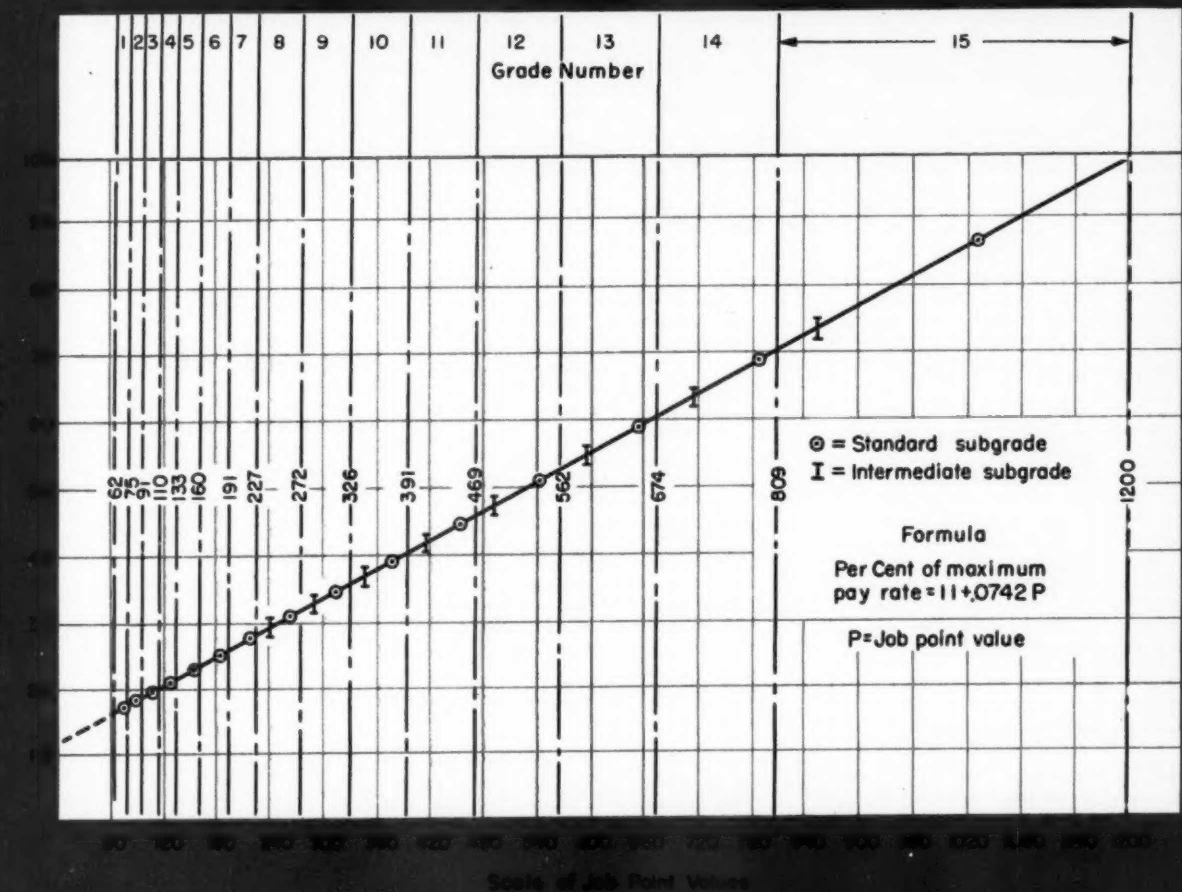


Chart giving the correlation between total job points and pay rates

company's plans and operations, and directing such information to the interested members.

This first and possibly most important single duty involves many component activities, of which a few may be selected, as follows, to illustrate:

1. Scanning tables of contents, indices, news items, advertisements and other material of current technical periodicals; selecting, marking and routing pertinent items
2. Scanning the general and trade press for notices related to interviews and speeches, personnel appointments, new products and materials announced, conventions and expositions, proposed legislation, patents issued, interpretations of law, changes in transportation schedules and other recent events pertinent to the company's affairs; selecting, marking, clipping and expediting attention to same
3. Reviewing catalogs and other source information on library materials such as books, periodicals, charts, patents, handbooks, bibliographies, abstracts, indices, directories, dictionaries, maps, statistics, standards and specifications, illustrations, photographs, motion picture films, library services and other general reference works newly offered by suppliers; obtaining and reviewing approval copies; selecting or referring for recommendation to acquire, and acquiring library materials suitable to the Technical Library program
4. Maintaining current the stock of manufacturers' catalogues pertaining to equipment, materials, supplies, processes and services with related specifications, applications, test results, prices, discounts, delivery schedules, operating costs and similar information; reviewing catalog information and disseminating notices of new information received.

These few samples will suggest to the reader many other vital activities which comprise this duty.

Client Requirements: Here a two-part duty is indicated:

> Taking the initiative in keeping informed generally of the company's plans, current operations and future technical information requirements; anticipating the needs of staff members and engaging in procedures to fulfill those needs.

The second duty noted is illustrated by the following typical activities:

1. Attending staff program meetings and learning of the technical character, status and schedules of the company's projects

1. Academic Training—Liberal:

Must have a liberal arts degree from an accredited school of collegiate grade, or the equivalent.

2. Academic Training—Specialized:

Must have a degree in library science from an accredited graduate school.

This qualification is really stiff and properly so. The information research director must be thoroughly trained in the procedures for accession, documentation, circulation and administration of the library functions. The corresponding entrance requirement for the information research technician would be a minimum of one year of graduate study, and for the information research assistant, two years of graduate study, or the equivalent.

3. In-Service Experience—This Occupation:

Must have had at least three years of experience as information-research assistant or the equivalent.

The phrase "or the equivalent" here admits of suitable experience gained in a job of a different title, but of equivalent content. When all of the experience required in the several jobs below that of information-research director are added together, the total experience requirement for that job may be as much as ten years. However, the qualification accepts working experience in any industry or company.

4. In-Service Experience—This Company (or Industry):

Must have had at least two years of experience in technical information research work in this company (or specified industry), or the equivalent.

If the previous qualification applies, it is not necessary that the specialized experience be gained at the information-research assistant level. The phrase "or the equivalent" here would accept experience in information research work closely related to the industry in a university, law or other library.

5. Resourcefulness:

Must have demonstrated marked resourcefulness in discovering the availability of record material over the complete range of sources, in locating pertinent material and in correlating information to client needs.

The qualified information-research director must select quickly from a considerable mass of reference information, determine in which directions and how far to reach for needed data, and then be able to adapt these findings for immediate usefulness.

6. Power of Visualization:

Must be able to visualize the end-objective of information research and employ an avenue of approach containing the minimum of error and uncertainty.

Time is of the essence in many information-research projects. The engineer is ready to use information almost as soon as he discovers what information he wants. Usually, he wants it within a matter of hours or, at the most, a few days. The situation contains no margin of safety for "cut-and-try" methods.

7. Adaptability:

Must have the ability to adapt and reorient herself or himself personally, over a range of problems, situations and personalities harmoniously and effectively.

The information-research director is the liaison between this function and all other branches of the enterprise. The director will encounter, and must adapt mental processes frequently to the new and involved problem. This quality demands a large measure of objective attitude and self-control.

8. Analytical Power:

Must be familiar with the fundamental analytical process as required to perceive the true character of information required, and to reject superfluous and unrelated data.

The initial leads from which the information-research director starts may be incomplete, inaccurate or even misleading. She or he must be able to avoid being started off in the wrong direction by these things, and determine by analysis the correct approach.

9. Knowledge of Prior Art:

Must have a working knowledge of the special sources of technical information pertaining to the industry or company served, and of the accepted procedures for obtaining possession of such information.

The information-research director cannot have the same intimate knowledge of prior art in a given field such as electronics as the electronic designer. Special knowledge would encompass, in this field, the important sources of technical information and the means of securing information from those sources.

10. Ability in organization:

Must be able to plan, subdivide, delegate, co-ordinate, supervise, schedule, follow-up, expedite and review the work of subordinates engaged in information research and library operation, in a manner that will obtain effective work results and co-operation.

The importance of this quality increases with the size of the information-research staff and the numbers of persons in other branches of the enterprise who may work with the director from time-to-time. Its importance is greatest when the director performs no research work and devotes full time to the direction of others in that work.

11. Power of Expression:

Must have demonstrated an exceptional capacity for written composition as required for concise, accurate and clear statement of technical fact, opinion and evidence. Must be able to make concise, accurate and clear verbal representations as related to the work.

Possibly the greatest skill in written composition is employed in reducing an involved subject to a statement of a few words, particularly when the subject is a technical one. Words must be selected and arranged with great care so as to avoid misconception. The accompanying reproductions illustrate the concise technical abstracts which require a considerable talent for preparation. Additionally, the director is required to participate in executive conferences, and to gain or lose by the effectiveness of his or her oral statements.

12. Personality:

Must have an attractive personality as required to inspire co-operation, confidence and active interest on the part of others; must have a talent for selling as required to stimulate the usefulness of the information-research service to the enterprise.

This qualification suggests the mildly-extrovert type of individual who is all "wrapped-up" in this work and completely assured of its importance. The director should be approachable, sympathetic and helpful, and should provide a practical attraction to the library and information-research service.

13. Dexterity:

Any work requiring more than ordinary dexterity as in the operations of Microfilm or Microcard readers, typing, filing, sorting, etc., on a production basis would normally be assigned to a library employee of lower grade. The information-research director has little need for exceptional manual dexterity.

14. Effort Intensity—Mental:

Must be capable of close and intensive study of recorded information, and of assimilating information not previously encountered but related to the technology of the company or industry served.

This qualification is particularly important in the younger person engaged in technical-information research and beginning to apply his or her library training to specialized research work. As the individual continues in this work over a span of years, his or her knowledge of the technology increases while the frequency of close study of new information diminishes. However, the minimum requirement of this capability in the highest positions remains high due to the continuing need to assimilate new technology as it is developed.

15. Effort Intensity—Mental Visual:

Must have the ability to create a clear mental concept of the end objective and of the approach to that objective; must have the ability to detect, clarify and comprehend pertinent, intangible and corollary factors.

Although relatively obscure and difficult to isolate or assess, this qualification is considered to be the most important single factor in creative work, and this is true of technical-information research work. The ability to satisfy this qualification is not inherent but is a product of the mental effort expended. Although accustomed by years of experience to the expenditure of mental effort, the information-research director continues to encounter new obscure problems and these call for the continued mental-visual effort at a high level.

16. Effort Intensity—Accuracy:

Must be able to formulate and work within the practical and economic standards of accuracy appropriate to the purposes of work assignments.

Literally, 100 per cent accuracy in the scope and depth of technical information researched is both unattainable and un-

economic. No one else can tell the information-research director just how far to go or just when to stop in the search for information. The director must make the decision concerning the accuracy and scope to be achieved, in many instances.

17. Effort Intensity—Manual:

When performing the work for which best qualified, the information-research director does not engage in physical work but delegates such work to others of lower classification.

18. Responsibility for Formulation of Policy:

Must be able to assume and carry out delegated responsibility for recommending, to supervisors of higher classification, policy for the conduct of the technical library and the information-research service.

The training and abilities of the information-research director are not fully utilized until they are employed in the development of related policy, in the same manner as the general counsel, chief chemist and other specialists in their branches of the business. Operating policy should be formulated by these people for approval by the executive group.

19. Responsibility for Supervision:

Must be able to assume and carry out responsibility for supervision of the members of the technical library and information-research staff including discipline, review and correction of their work, and the operation of the assigned facilities.

The importance of this qualification will increase with the numbers and classifications of subordinates supervised.

20. Responsibility for Training:

Must be able to assume and carry out responsibility for training, counsel and instruction of technical library staff in both library practice and information-research work; must be able to assume and carry out delegated responsibility in connection with the company's in-service training program for all its employees.

The outstanding performer is not always a good teacher, and vice versa. Whereas good performers are admissable to the lower jobs without particular teaching abilities, those abilities are required of the information-research director to perpetuate the service and to prepare a successor.

21. Responsibility for Personnel Requirements:

Must be able to assume and carry out responsibility for minimum technical library and information-research staff consistent with satisfactory performance of the work.

Again, the information-research director is responsible, without benefit of enlightened counsel within the company, for efficient performance of technical library work, with a minimum payroll. The director must accept responsibility for justifying increases in staff or payroll in practical terms.

22. Responsibility for Personnel Status:

Must be able to regulate the status of library and information-research staff for effective and harmonious performance of the work.

The director must be responsible for the appraisal and rating of the staff, for appropriate promotions and other actions necessary for preserving top efficiency.

23. Responsibility for Company Property:

Must be able to assume and carry out responsibility for the preservation, proper handling and discreet protection of technical library materials including confidential reports and information, and for assigned equipment, supplies and special devices.

Many information - research assignments relate to new technical art in the preliminary and confidential stage. The director may also be responsible for limited company petty cash funds and costly equipment and supplies.

24. Responsibility for the Property of Others:

Must be able to assume and carry out responsibility for the property of others including borrowed reference material.

The director must take responsibility for the company for routing, follow-up, preservation and return to owners of borrowed reference material which may include rare and precious books, scientific treatises, confidential information and the like.

25. Responsibility for Health and Safety:

The technical library normally contains no special hazards to health and safety, nor are technical library employees required to go into other areas which might be dangerous.

26. Inherent Personal Qualities—Self Confidence:

Must have a healthy degree of self-confidence as needed to inspire the confidence of others and enlist support for the technical library and information-research service.

The information-research director should display the degree of modest confidence in the information-research function which captures the support not only of the staff served directly, but also of the executive group.

27. Inherent Personal Qualities—Respect for Perfection:

Must have demonstrated esteem for practical perfection in work results, conditioned by sound judgment of temporal and economic limitations.

This qualification seeks a nice balance in personal work standards between true perfection on the one hand and practical restraint of effort on the other.

28. Inherent Personal Qualities—Capacity to Receive Criticism:

Must have the objective attitude, equanimity and good judgment needed to withstand criticism, to ignore that which is unfounded and to profit from that which is useful.

The technical library must consider itself as the servant of all other branches of the business, and the inevitable recipient of various forms of criticism. While it is not suggested that the information-research director should be the whole company's scapegoat, it is believed that there is some clue to a better method in almost any form of criticism. The director should be smart enough to find those clues and to use them to advantage.

29. Inherent Personal Qualities—Ethical Honesty:

Must have demonstrated a marked degree of integrity in respect to work standards and results.

The information-research director usually has but one judge of work quality and that judge is conscience. The director must be able to judge the work impartially, to persist in seeking the best end results and to develop the quality in subordinates.

30. Inherent Personal Qualities—Spiritual Honesty:

Not being entrusted regularly with large sums of money or other strong lures away from ordinary spiritual honesty, the technical library staff need have no higher qualifications in this regard than other office and clerical employees.

31. Inherent Personal Qualities—Endurance:

Must have the necessary physical stamina to endure moderately abnormal work pressure occasionally for short periods of time.

This requirement has some meaning when an urgent information-research project requires a few hours of overtime work for a few days.

32. Inherent Personal Qualities—Concentration:

Must have demonstrated the ability to concentrate closely as required in receiving work assignments, ignoring distracting environment and performing involved research tasks.

A person having little or no inherent capacity for concentration or for ignoring distractions can lose too much time in completing an involved information-research assignment. However, the frequency of possible distraction is not high in the well-run technical library.

33. Inherent Personal Qualities—Co-ordination:

This qualification relates to co-ordination between mind and hand as in the delicate control of mechanisms according to observations of effects and judgements of anticipated effects. It is not a prime requirement in technical libraries.

34. Application:

In a type of work which attracts and interests the worker, in contrast to the apprentice's "job," application is almost automatic and does not require a specification. However, for purposes of evaluation of the information-research director's job, it is necessary to recognize that the incumbent give up a goodly portion of personal time for outside study, attendance to and support of professional library organizations and other similar activities which carry no additional compensation.

2. Conferring with staff members from time to time individually and obtaining detailed information relating to the progressive needs for the library
3. Planning and carrying out procedures to select, obtain and supply pertinent technical information as required by project schedules.

Exchange Arrangements: This is a little-recognized but important duty.

Establishing and maintaining the appropriate professional memberships, contacts and mutually-agreeable working arrangements with other library services to supplement the company's technical library resources, and to take appropriate advantage of progress in technical library science.

This duty illustrates the area in which a company's senior executives cannot be fully qualified to exercise close supervision over a technical library operation, but must rely upon, and accept the judgment of the information research director as to the scope in which the responsibility is carried out. Such executives must be prepared to allow considerable latitude, and to judge the performance of the technical library director in terms of overall results and over a period of years. This duty contemplates these activities:

1. Obtaining and maintaining active memberships in the appropriate national and local associations and chapters of practicing technical librarians; subscribing to and keeping informed of the contents of association publications; preparing papers for publication to secure interchange of experience and opinion on the company's practical problems of technical library operation
2. Visiting other technical libraries to observe their operations and to gain information useful in improving the company's technical library services; attending conventions, expositions and displays and obtaining useful information; receiving and assisting visiting representatives of other technical libraries, and exchanging experience, opinion etc.
3. Establishing and maintaining mutually-agreeable working relationships with other libraries for the exchange and loan of books, periodicals and other library materials; assuming responsibility for carrying out agreements in connection with the protection and return of borrowed materials.

Inasmuch as this duty should be made mandatory, it follows that the employer must assume the travel, subsistence, communications and other personal expenses incurred by the technical library director in carrying out the duty. However, such expense should be regarded as a sound investment, both in the perfecting of a company's technical library services to its staff, and also in public relations.

Interpretation of Library Service: In the larger companies which utilize its technical information resources as a primary tool of public relations, the following activity may be included under the duty mentioned in the foregoing.

Advertising the company's prepared technical information resources such as motion picture film, pamphlets, displays and related material for loan as prescribed by company policy; accepting requests, scheduling and making shipments; following and obtaining return of loaned material, as scheduled; making suitable arrangements for safe storage and necessary repair of loan materials.

An essential element in building the effectiveness of a technical library within an organization is the stimulation of the interest of staff members in the library services, and the obtaining of that interest is a responsibility of the technical library director. In short this duty can be stated as:

Stimulating and obtaining active interest and usage of the company's technical library services by all members of the technical staff.

Although stated very briefly, this duty may encompass a great many component activities, such as:

1. Preparing and using printed notices such as notices on bulletin boards, in the company's house organ, in letters to branch offices, on bookmarks, in abstracts circulated among the staff members and other available media
2. Arranging personal contacts with staff members at their work places and in the technical library, and explaining available resources and services
3. Rendering personalized services in obtaining and supplying information related to the personal affairs of staff members such as road maps, vacation folders, reading lists, special catalogs and other free printed material; maintaining subscriptions and making available such fictional and entertainment reading material as may be provided by the company's policy and authorized budget
4. Preparing and maintaining attractive displays of library materials including models, citations to staff members, graphic materials prepared by staff members, rare books, samples of raw or crude substances and other articles of current interest
5. Preparing and circulating periodic reports of the technical library operations relating to resources, activities, services rendered, expenses and future program.

Budgeting: The research director's broadest single responsibility is that of preparing the annual, overall plan of library operations commonly known as the budget. Being unrelated to library science but tied closely to the employer's particular budgetary procedure, the annual budget spasm can be an unadulterated headache, but no one else but the director can make the library's budget mean anything.

To many budgeteers, a budget is merely a list of figures—usually expenses and rarely revenues—projected from last year's budget or plucked from thin air, and accompanied by no more than a casual reference to what the company may expect to get for its money. Therefore, this word to technical librarians: Make your budget estimates tell a dramatic story or forecast, qualitative as well as quantitative, of the number of books, periodicals and abstracts you will circulate and to how many staff members; the number of inquiries and researches anticipated; your schedule of visits to other libraries and of visitors you expect to receive; your plans for publicizing your technical library services to your staff and to your company's customers and friends; and any-

thing else of a realistic nature which will help your comptroller to understand that for each dollar authorized in your budget, the company will receive in return dividends of good value. Thus the technical library director has a vital duty which reads something like this:

> Estimating, projecting, preparing and justifying the annual technical library budget in terms of objects and purposes of expense and capital investment; attending budget conferences and supplying explanations of budget items, as required; reporting expenditures and assuming responsibility for controlling library obligations within authorized budget limitations; presenting supplementary budget information as required by changes in company policy.

Budgetary procedure is about the same in a technical library as in a machine shop, dairy farm, sports arena or other establishment. The objects of expense—wages and salaries, materials and supplies, reproduction services, space charges, travel and subsistence, etc.—have the same meaning wherever used, and the formulae for distribution and allocation of overhead charges are about the same, as the public accountant will agree. Therefore, this article will not attempt to reiterate any of the voluminous material already in print on this subject.

Supervision: Supervision of technical library employees is an important responsibility of the technical library director who is charged with a duty such as the following:

> Working with, directing and assuming responsibility for the work of technical library employees of lower classification engaged in; requisitioning, receiving, checking and recording library materials; classification and cataloging; indexing, marking and placement; issuing and control of circulation; preparing abstracts and digests; making interlibrary loans and following up scheduled returns; preparing notices, assembling exhibits and displays; maintaining current records on library activities, expenses and services.

This duty also encompasses many varied activities such as:

1. Instructing and training employees in the performance of their duties
2. Interviewing and selecting or recommending for selection, new employees
3. Making periodic ratings of technical library employees' merit ratings; taking or recommending action to promote, demote, discipline or teminate employees, as required
4. Assigning and reassigning duties for the purpose of broad development of technical library employees' capacities.

When this duty is properly carried out, the mechanics of routine operation are carried on efficiently with a minimum of supervision, and the technical library director is left free to conduct those highly-skilled and specialized duties which only he or she is capable of conducting.

Employee Training: No branch of a company organization is better equipped to support or carry out an in-service or on-the-job training program than the technical library. Its contribution should include the selection, procurement and circulation of reading material, conduct of discussion meetings and many related activities. The duty covering these activities might read:

> Participating in the planning, establishment and conduct of employee-training programs; selecting, procuring and circulating appropriate study material; conducting discussion meetings: carrying on other training activities as required by the director.

QUALIFICATIONS OF THE INFORMATION RESEARCH DIRECTOR: Having spelled-out a few typical duties which illustrate the responsibilities of the information-research director, let us now consider the qualifications to be required in filling the job. These are entering qualifications, as distinguished from the capabilities to be developed after considerable further experience in the job. It is important to keep in mind that, whereas duties reflect the job content wholly apart of the individual who occupies the job, qualifications reflect the capabilities of the individual

Table 2—Job Evaluation by Factors

Job Factor	Max.	Above Avg.	Avg.	Below Avg.	Min.
Skill					
Academic Training—Liberal	30	24	**18**	12	6
Academic Training—Technical	40	32	**24**	16	8
In-Service Experience—This Occupation	60	48	36	**24**	12
In-Service Experience—This Company	30	24	18	**12**	6
Resourcefulness	60	48	36	**24**	12
Power of Visualization	50	40	30	**20**	10
Adaptability	50	40	30	**20**	10
Analytical Power	50	40	30	20	**10**
Knowledge of Prior Art	35	28	**21**	14	7
Ability in Organization	35	28	21	**14**	7
Power of Expression	30	24	**18**	12	6
Personality	40	32	**24**	16	8
Dexterity (not pertinent to the job)	50	40	30	20	10
Subtotal, skill factors					229
Effort Intensity					
Mental	40	32	24	**16**	8
Mental Visual	110	88	66	**44**	22
Accuracy	75	60	45	30	**15**
Manual (not pertinent)	75	60	45	30	15
Subtotal, effort factors					75
Responsibility					
Formulation of Policy	75	60	45	30	**15**
Supervision	20	16	12	**8**	4
Training	10	**8**	6	4	2
Personnel Requirements	10	8	6	4	**2**
Personnel Status	10	8	6	4	**2**
Company Property	9.0	**7.2**	5.4	3.6	1.8
Property of Others	8.0	6.4	4.8	**3.2**	1.6
Health and Safety (not pertinent)	8.0	6.4	4.8	3.2	1.6
Subtotal, responsibility factors					45.4
Inherent Personal Qualities					
Self-Confidence	40	32	**24**	16	8
Respect for Perfection	30	**24**	18	12	6
Capacity to Receive Criticism	25	20	**15**	10	5
Ethical Honesty	15	12	**9**	6	3
Spiritual Honesty (not pertinent)	15	12	9	6	3
Endurance	15	12	9	**6**	3
Concentration	15	12	9	**6**	3
Coordination (not pertinent)	15	12	9	6	3
Subtotal, inherent personal quality factors					84
Application	20	**16**	12	8	4
Grand Total, all factors					449.4

who is eligible for appointment to the job.

It is important to keep in mind, also, that job classification in terms of duties and qualifications, is not an "exact" science in the sense of mathematics or bookkeeping, or even in the engineering sense. Rather, it is a relative art which employs considerable judgment in the correlation of elements and values and in which exactness is a matter of choice of words to define relative degrees of education, experience, knowledge and other qualifications.

A job series consists of two or more jobs associated together in the carrying out of a variety and range of duties contributing to the same common purpose. The jobs within a series are arranged in vertical succession like the rungs of a ladder, with each job having greater scope and importance than the job just beneath it. That scope and importance is indicated by the title. The process of subdividing all duties in the series into job-groups in such a manner that all duties in the same job-group have the same relative scope and importance is called job classification. Likewise, qualifications are classified so that all qualifications for a given job match the duties for that job and are distinguished in degree from the qualifications of the jobs just above and beneath the given job.

Although job classification as a whole is not an exact science, that part of job classification which relates to qualifications is relatively exact and must provide the firmest possible basis for judging the eligibility of individuals. However, some qualifications can be fulfilled in more than one way. For example, extensive working experience coupled with informal study might develop specialized knowledge to a degree equivalent to a period of formal academic training, and a person should not be disqualified improperly for lack of formal education. For this reason, the phrase "or the equivalent" is attached to certain qualifications.

Summary: The qualifications of the information-research director may be summarized in the general qualification as follows:

> Must fulfill the company's general qualifications and, in addition, must have all the qualifications of the information-research assistant.

General qualifications refer to such matters as health, citizenship, willingness to abide by company policies, and other conditions of employment which are binding in equal degree upon all employees of the company. In the accompanying listing entitled, classification listing of job requirements, the various important factors to consider are detailed.

More than one of these listed qualifications are quite stiff, particularly when it is recognized that they are "entering" qualifications for the job. In relation to the qualifications for the next lower job such as the information-research assistant, they do not represent any improper demands. As stated earlier in this article, the profession of technical-information research should be self-motivating and self-governing in a manner to win the right of full self-determination. Only the most highly-qualified individuals can hope to fulfill that destiny.

Rating the Research Director

Evaluation of the Position: Having "spelled-out" the duties and qualifications of the information-research director, it may be of some interest to fit this job into its proper place in an organization, and to see which "slot" the job falls into. We can do this by evaluating the job, factor-by-factor, and applying for each factor that degree and number of points which measures the job requirement.

No job can be evaluated purely in the abstract or without known relationship to other jobs. Furthermore, any job can be evaluated *only* in relation to the other jobs within the same organization, industry and community.

Therefore, before we can accurately evaluate the job of information-research director, we must set up a hypothetical organization with its scope and diversity clearly understood, as the framework within which this job is considered. For this purpose, we shall consider the type of organization which would make the fullest demands upon the technical library, and also in which the information-research director is regarded as an integral member of the creative technical staff.

Any one of the following types of organization is eligible for the desired background:

1. A large manufacturing company engaged in the production and marketing of a variety of specially-engineered products, and in the creative development of many new products, both in two or more basic areas of practical arts such as electrical, medical, chemical and other branches of research and engineering
2. A professional organization engaged in creative work for many clients in different manufacturing industries
3. A large university in which the library staff is required to assist, work with and contribute to a diversity of post-graduate research
4. A large Government agency engaged in a wide variety of basic research affecting the whole national economy in such areas as agriculture, finance, transportation, etc.
5. A large metropolitan public library having a well-used information-research service.

The topmost job level to which the job of information-research director is related in our hypothetical organization is that of the vice president in charge of research or the vice president in charge of engineering in the large manufacturing company, the project manager in the professional engineering organization, the university department head or the director of research in the government agency. The salary range at that level will be from $15,000 to $25,000 per year. A minor part of the organization framework for evaluation is the number of persons supervised and we

shall assume that our hypothetical technical library group supervised by the information-research director includes the seven shown in the Chart of Functional Distinctions.

For continuity, the evaluation formula described in the article, "Evaluating Engineers" published in the June, 1951, issue of MACHINE DESIGN, will be used to evaluate the job of information-research director. The sum of the maxima of the 34 job factors used in this formula is 1200 points which, theoretically, can be applied to the same top-level job.

EVALUATION BY FACTORS: The whole point-value range for each job factor is shown in TABLE 2 titled, Job Evaluation by Factors. Also, the degree and value assigned to the job of information-research director is indicated by the bold figures.

Thus we find that the position of information-research director, when utilized to maximum effectiveness, evaluates at about 450 points in a total scale of 1200 points, or 37½ per cent. The correlation between total job points and pay rates is shown by the chart, Contents of Job Grades. This chart shows that a job having a total point value of 449.4 falls in Grade 11. The pay rate for any total point value is computed in percentage of total pay rate according to the formula, $S = 11 + 0.0742 \times P$ where S is the salary rate, in per cent of total, and P is the total point value of the job. The point value and per cent of total pay rate for the subgrades of Grade 11 are as follows:

Subgrade	Points	Rate (% of total)
Entrance	391	40.01
Intermediate	412	41.57
Standard	451	44.46
Merit	469	45.80

In an organization where the maximum pay rate subject to the evaluation formula is $15,000 per year, the evaluated standard pay rate for the information-research director is $6669. This rate has been equaled or exceeded in several effective technical libraries.

Building for The Future

Future Prospects of Technical Information Research: There can be no doubt of the future of technical information research. The function is rapidly winning recognition in industry, Government agencies, universities and elsewhere that research and creative effort are carried on. Possibly the day is near when any organization having as many as 100 persons engaged in such work will regard its technical library to be as important as its accounting, administrative and other established services.

The principal brake on the expansion of information-research is the lack of competent people to perform the work. This lack is evident when we recall the duties and qualifications enumerated herein. There are, however, ways to remove this brake and build a supply of trained people qualified for technical information-research work.

The enterprises which stand to gain from the results must take the initiative. Like the scholarships provided by industry for engineers and technicians, scholarships, could also be offered to attract more enrollments in special library courses. Following graduation of trainees from college and during their periods of postgraduate training in library science, industry might co-operate by offering intermittent or part-time employment in their technical libraries, much as is the manner of co-operative engineering education. By rotating scholastic training with intermittent employment in the same company or industry, the librarian-graduate enters upon full-time employment richly qualified to perform information-research at a high level and to aim for the director's job within a few years.

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SCANNING the Field For Ideas

Scissors principle for cutting extruded rubber and synthetics is utilized in the special machine illustrated below for making wringer rolls of exact length. Cutter action is shown in the insert with the cover lifted. The blades are driven by counter revolving shafts through bevel gearing and a solenoid-actuated single-revolution clutch. A 9-inch flywheel, driven by a 1/4-horsepower motor, supplies energy for cutting which otherwise would require 5 horsepower.

Inasmuch as the cutting action is balanced and obtained between the opposed blades travelling through an arc of about 30 degrees, there is no reaction through the cutter mounting which otherwise might cause deflections and inaccurate cuts. Speed of the cutter blades is 300 rpm, effecting a cut in about 1/30-second.

In this machine nineteen unit cutter heads are synchronized and spaced to make exact lengths between each cutter. Individual cutters are self-contained and mount on the machine rail. Adjustment for length of cut between the heads is provided for by a rack and gear arrangement. Power and control circuits are plug-in connections, making it simple to change cutter arrangement and to replace the heads.

Lengths of stock are fed to the conveyor from the side. When the stock reaches position, all cutters operate simultaneously. The cut lengths fall into the diagonal troughs and are delivered to the end of the conveyor. Sequencing of all functions of the machine is controlled by a series of cam-operated switches. These cams are mounted on vertical spindles and can be modified quickly for changing the machine cycle. A variable-speed transmission drives the machine through an overload release clutch to prevent damage in event of a jam or overload.

Because of the speed of operation of these cutter units they have also been employed individually direct on the conveyor from a tubing or extruding machine, cutting to length without distorting the product even though it travels continuously.

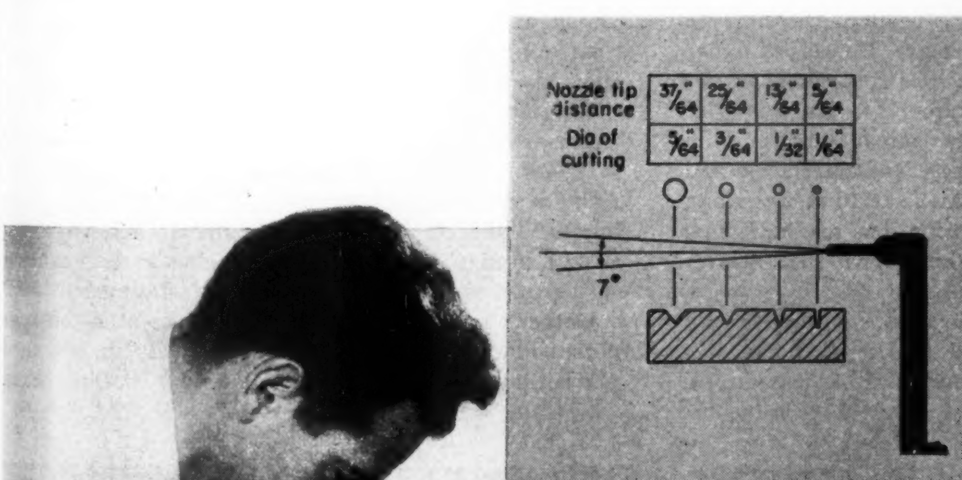
Cutting with gas-propelled abrasives, below, provides a fast and accurate method for high-precision operations such as removing of metallized films from glass and ceramics, drilling thin sections of hard-to-work materials, etching, light deburring, and polishing. Developed by S. S. White Industrial Division, the unit directs the gas-propelled abrasive stream against the work surface through a sintered tungsten-carbide nozzle. As it leaves the nozzle the stream travels at approximately 1100 feet per second and is only 0.018-inch in diameter.

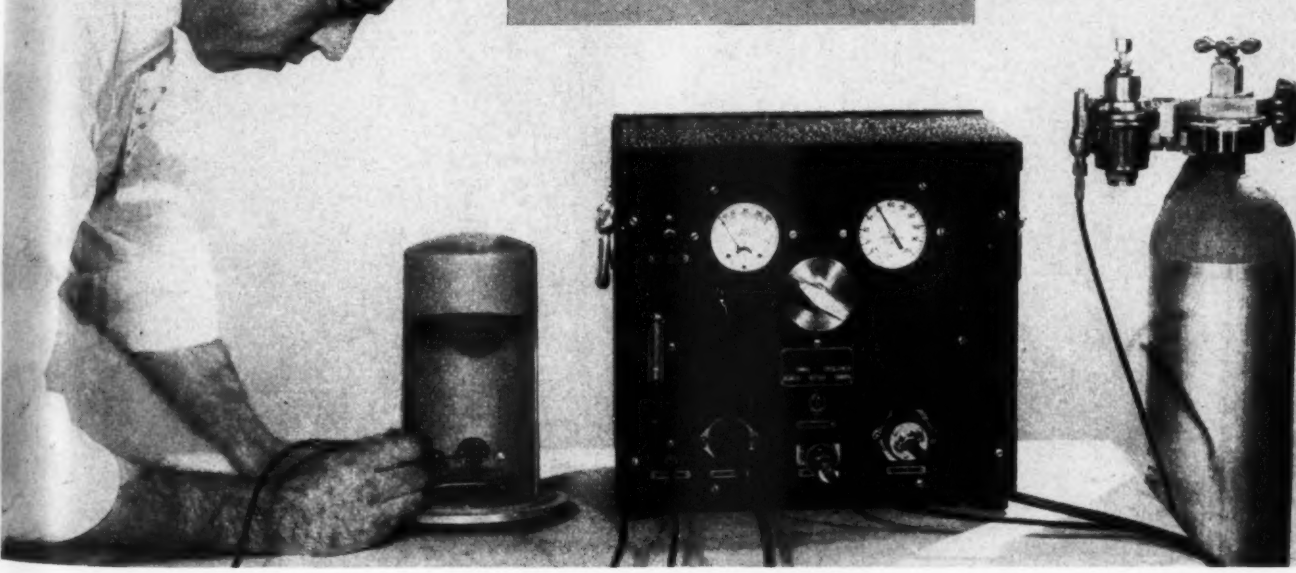
Action is accomplished without the usual heat generation and without the pressure and vibration ordinarily experienced with other cutting methods. This has been of particular significance when working on materials such as germanium whose physical or electrical properties might be affected by heat and shock. Because there is no direct contact of a tool with the work, dimensional variations that might set in due to wear of the cutting tool or by surface irregularities are eliminated with this method of cutting.

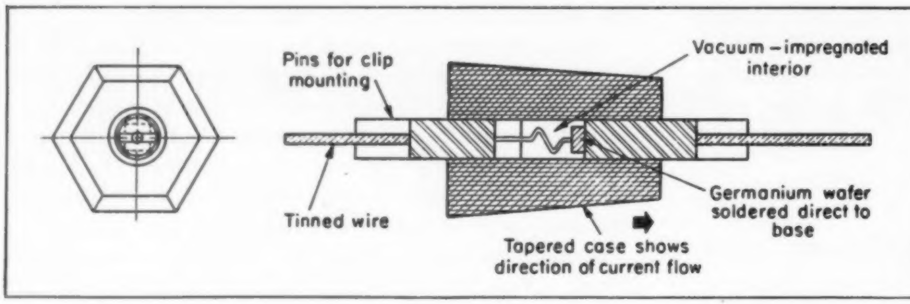
Any dry inert gas such as carbon dioxide may be used as the propellent. Normally, a specially processed aluminum oxide powder is the abrasive. For certain applications which require lighter cutting, a classified Dolomite (a mixture of calcium and magnesium carbonate) is employed. Standard commercial grades of abrasives are not suitable.

Stream emerging from the nozzle is a cone with about a 7-degree included angle. Pattern of cut with respect to nozzle distance from the work is illustrated in the diagram. As an indication of cutting speed, the unit will remove about one milligram per second when cutting glass with the nozzle ¼ to ½-inch from the work.

Despite the ease with which the unit cuts hard and brittle surfaces, it has practically no effect on resilient or soft materials such as rubber, cloth and certain types of plastics. This selective cutting effect is useful in removing metallized films coated on a relatively soft base.







Germanium diodes, above, designed to replace electronic tubes such as detectors and rectifiers, are proving dependable for use in electronic circuits and controls. Less expensive than tubes because they are easier to produce, they require less wiring and space, generate less heat when in use, and are cheaper in operation without impairment of efficiency.

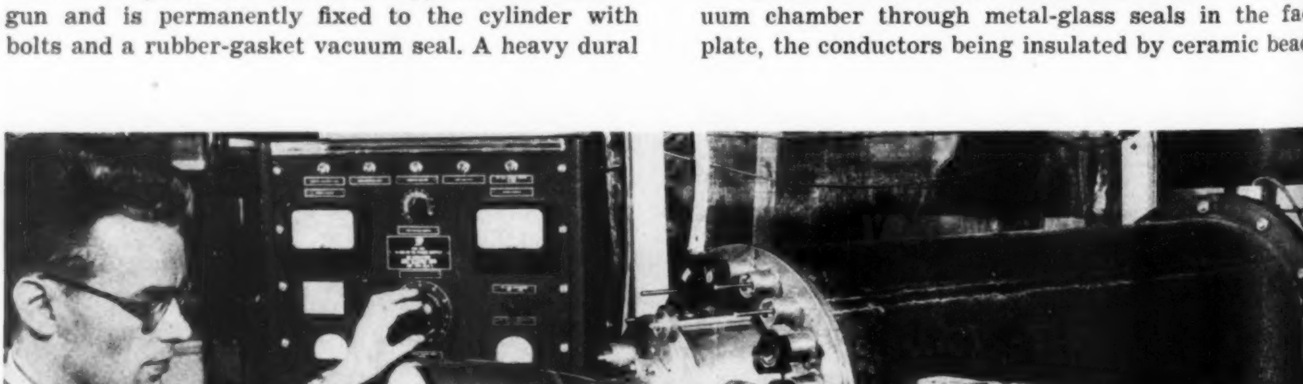
The germanium diode illustrated and manufactured by Radio Receptor Co. has a tapered case to indicate polarity, facilitating assembly operations and inspection. The unit consists of a germanium wafer soldered to a nickel alloy cathode pin and an electroetched tungsten whisker welded to a nickel alloy anode pin. The unit is assembled in a glass phenolic body and is impregnated with a polyethylene compound using the vacuum-pressure method.

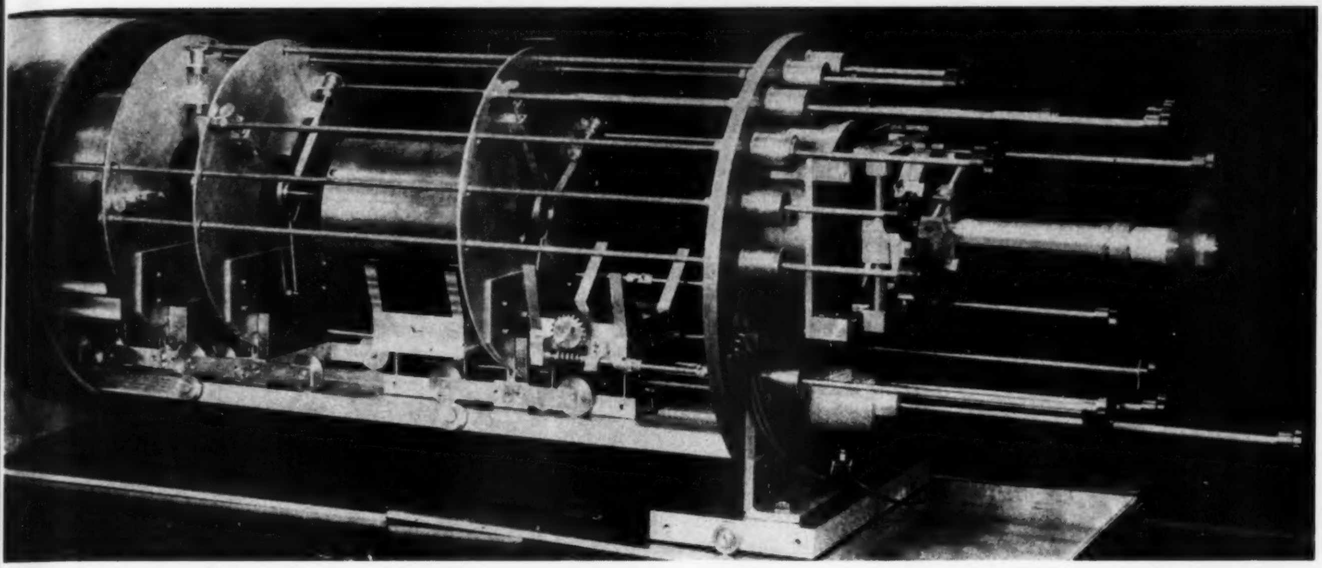
Precise adjustment of components within a vacuum chamber is accomplished through external mechanical controls in the electron-optical bench illustrated below. This bench is an integral part of a program at the National Bureau of Standards to investigate extremely small electric and magnetic fields in spaces that have heretofore been inaccessible to conventional types of measurement. Developed under the direction of Dr. L. Marton, it is made with an all-metal cylindrical vacuum chamber for simplicity of construction and for protection against X-rays. It is designed to accommodate three lens carriages and four holders, to permit a movement of 10 inches along the axis of the bench, and to allow one-half inch radial movement for each component of the system without breaking the vacuum.

One end plate of the bench supports the electron gun and is permanently fixed to the cylinder with bolts and a rubber-gasket vacuum seal. A heavy dural plate serves as the bed for the system and is provided with wheels so that the whole system may be rolled in or out of the chamber as shown in the view at the top of the next page. The face plate is sealed against the end of the cylinder by a neoprene gasket compressed by atmospheric pressure. A fluorescent screen and "Wilson seals"—through which pass the connecting shafts that control the motion of the elements—are inserted into the face plate.

Radial adjustment of each element is obtained by worm and gear arrangements to combine vertical and horizontal motions of the lens carriage and holders. Axial position of the carriage is controlled by pushing the connecting shafts through the Wilson seals. Radial motion is constrained by elastic deformation of phosphor-bronze strips instead of sliding surfaces.

Current leads for the electron lenses enter the vacuum chamber through metal-glass seals in the face plate, the conductors being insulated by ceramic beads





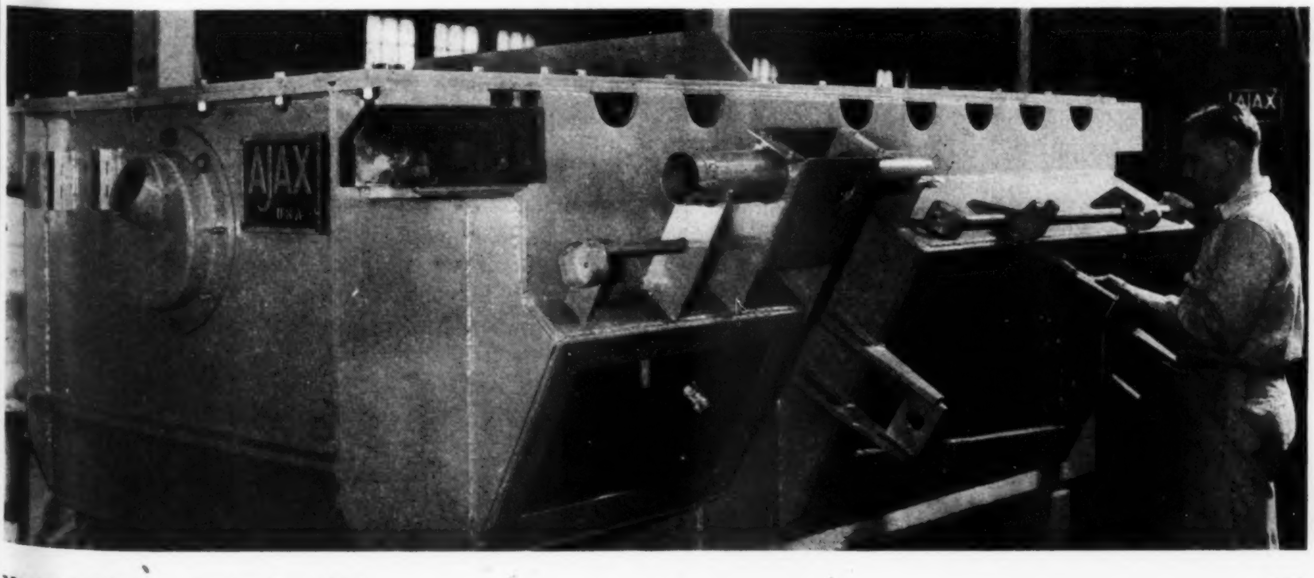
which produce less outgassing than would rubber or plastics. A large fore-pump brings the pressure in the chamber to about 10 microns of mercury in five minutes. A 4-inch oil-diffusion pump maintains the operating pressure of about 0.03 microns.

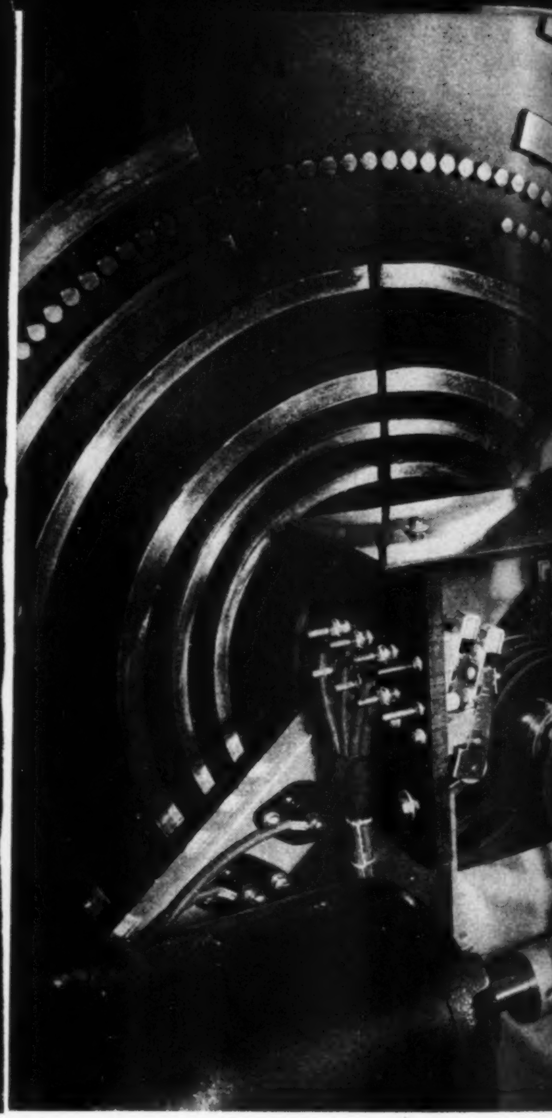
For the high-voltage supply a conventional 100-kv X-ray power unit is employed. Lens currents are supplied separately from a power unit that yields currents up to 500 milliamperes. The grid bias for the 100-kv electron gun is obtained from a potentiometer connected across three 45-volt batteries in series.

The test setup shows the bench being employed as an electron diffraction camera. The electron-optical lens which produces diffraction is connected to the front of the bench and a cathode-ray tube is inserted to permit observation of the transmission pattern.

Stainless steel thread inserts in the induction furnace, below, have overcome serious maintenance problems. Because it is sometimes desirable to replace inductor units, simple and rapid disassembly of the furnace is desirable. Use of flanges for bolts and nuts would introduce undesirable design elements. Such a flange would separate the two elements of the furnace by three or four additional inches. Also, it would add considerably to welding cost. For these reasons, cap screws are employed in tapped blind holes.

Because these bolts are exposed to temperatures of about 200 F and are close to an intense magnetic field, they decarburize, become brittle and often fail as a result of seizure when removal is attempted for maintenance. Seeking to avoid this seizure problem the manufacturer experimented with various classes of thread fits and with brass bolts but neither prevented failure. Stainless steel thread inserts, however, solved the problem. Some of the trouble may have stemmed from the action of the magnetic field on the unprotected bolts. The inserts, made by Heli-Coil Corp., are only slightly magnetic and probably protect the bolt from the magnetic action.





By R. B. Immel
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ADDITION of permanent magnets to the contacts on direct-current switches provides an effective arc blowout field and greatly increases their interrupting capacity. This improvement has eliminated the necessity for additional contactors and relays normally required to handle the circuits of standard manual master switches. Often, a single switch unit with a permanent-magnet blowout can handle a circuit normally requiring two standard switch units in series.

When standard switch units are used in manually operated direct-current control devices, the duty may be extremely severe because the operating speed depends entirely upon the operator. Slow opening of the switch often severely burns the contacts. When a permanent-magnet blowout field is employed, however, the speed of operation is of no consequence. The arc will be blown out just as soon as it is drawn between the two separating contact surfaces.

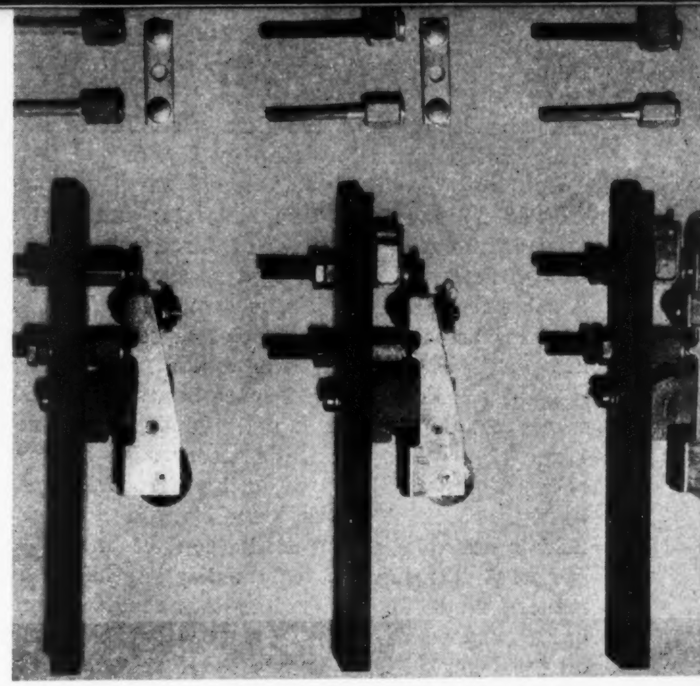
Illustrated in *Figs*. 1 and 2 are typical applications employing magnets on the contact assemblies. *Fig*. 1 is a totally enclosed and watertight master switch for a cargo winch. This type of cam-operated switch is also used widely in heavy industry such as in steel mills and in mines. Cam-operated contacts are also employed in the auxiliary switch assembly for the motor-operated master switch, *Fig*. 2, for steel mills. Because of the magnetic blowout, slow operation of the rheostat arm is of no consequence and the rating is greatly increased.

In *Fig*. 3 is a comparison of a standard switch unit with a switch unit having a permanent-magnet blowout only on the stationary contact and a switch unit having a permanent-magnet blowout on both the stationary and moving contacts. Both switch units with permanent-magnet blowouts have the same width as the standard switch unit without blowout. This feature makes the blowout easy to apply because it

Fig. 1 — Extreme Left — Manually operated master switch for a cargo winch. Permanent-magnet blowouts are mounted on the contact assemblies

Fig. 2—Left—Motor-operated rheostat for steel-mill service. Switch units with permanent-magnet blowouts are used in the cam-operated auxiliary switch

Fig. 3—Right—Master switch contact units showing standard switch unit without blowout, left, with permanent-magnet blowout on the upper stationary contact only, (center) and with permanent-magnet blowouts on both the stationary and moving contacts (right)



Permanent Magnets

. . . Increase capacity and life of switch contacts

will mount in exactly the same space requirements.

Effectiveness of magnetic blowouts is vividly illustrated in *Fig*. 4. These curves were plotted from actual tests made with identical resistive loads and under the same switching and arc interruption evaluation methods. The upper curve distinctively shows the greatly increased interrupting capacity obtained by adding a permanent magnet blowout to both the stationary and moving contacts.

Magnetic Field for One Magnet: A simple test setup, *Fig*. 5, is useful for determining the field strengths at various locations. A Lucite plate, arranged to hold the magnet in a specific location with respect to a series of uniformly spaced holes, makes a convenient fixture for plotting the field.

Various grades of Alnico magnet materials can be readily compared and consistent results can be secured in a relatively short period of time. A Gauss Meter which has a 5-inch long by 0.090-inch diameter probe is used for checking the points which are relatively close together. This instrument not only indicates the field strength in gausses but also shows the flux direction. This is a direct acting instrument and no search coils are required. The deflecting torque to operate the Gauss Meter results from direct interaction between the flux under investigation and that of a small magnet located inside the probe.

Distribution of a magnetic field is shown in *Fig*. 6 and was obtained by sprinkling iron filings on a piece of paper lying on top of an Alnico II magnet. This simple means of determining the direction of the flux lines is useful in comparing fields obtained from other magnet shapes and assemblies.

Typical flux density values with respect to the magnet and contact line for a single permanent magnet are showing *Fig*. 7. This data was secured with the test set-up shown in *Fig*. 5. It may be noted

that the direction of the flux is similar to the flux lines in the iron filing map in *Fig.* 6.

Field Produced by Two Magnets: An iron filing map of the magnetic lines of force, when the poles of two magnets are arranged so that the North and South poles are in series, is shown in *Fig.* 8. Lines of force between *N* and *S* poles of separate magnets are practically perpendicular to the face of the magnet. Also, there is a dead space between the magnets where the field is weak and the lines of flux converge. This field is unsatisfactory as a blowout because the flux lines would be practically parallel to the arc in a switch assembly. In addition, the field is not very strong at the contact line.

Actual interrupting tests indicated that two permanent magnets arranged in this manner were not quite as good as a single magnet on the stationary contact only. *Fig.* 9 shows the flux density values for two permanent magnets arranged so that the opposite poles are in series with each other. In this arrangement, the flux density at the intersection of the contact line and the centerline of the magnets is 110 gausses. For the single magnet in *Fig.* 7, a flux density of 155 gausses was found at this point.

An iron filing map of the flux lines, *Fig.* 10, has the two magnets arranged so that the poles repel each other. This arrangement is actually used on switch units with permanent magnets on both the stationary and moving contacts. It should be noted that the flux lines are uniform and are parallel to the pole faces of the permanent magnets. For a switch assembly they would also be perpendicular to the arc drawn when the contacts are separated.

Actual flux density is indicated in *Fig.* 11 for various points when two magnets are arranged so that like poles are opposite to each other. While the magnetic fields of these two magnets oppose each other, they are far enough apart so that one does not appreciably demagnetize the other enough to impair the combined magnetic blowout field. Magnets so arranged eventually stabilize at a flux density value slightly lower than the original open-circuit value. However, this flux density is still sufficiently high to provide effective arc blowout.

When the flux density reading at the intersection of the contact line and the centerline of the two magnets is compared with a similar point for a single magnet as shown in *Fig.* 7, it should be noted that the flux density for the two opposing magnets as shown in *Figs.* 10 and 11 is approximately twice the value for a single magnet.

For the stationary contact assembly, a solid silver contact button is spot welded to the brass support. A nonleaded brass must be used for the contact support as the relatively high current required

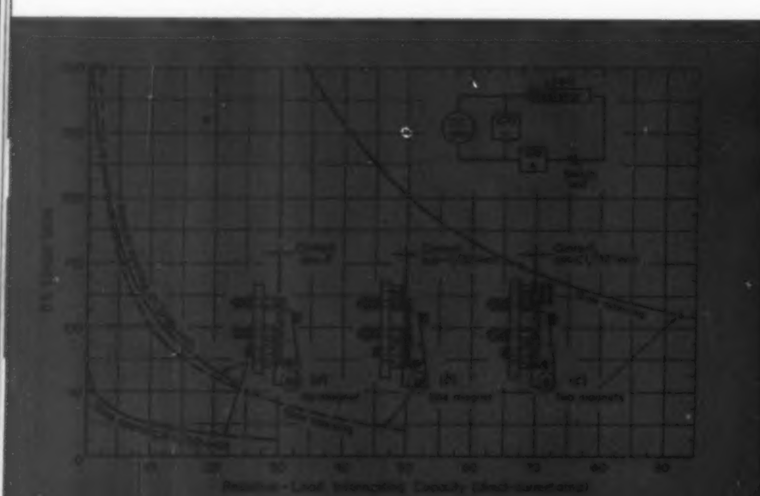


Fig. 4—Above—Comparison of interrupting capacity for switches both with and without blowout means on a dc resistive circuit

Fig. 5—Right—Fixture and instrument for determining and comparing the field strength of various points in a permanent-magnet field

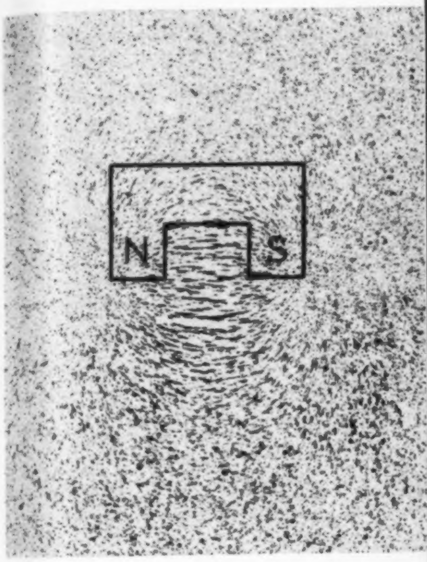
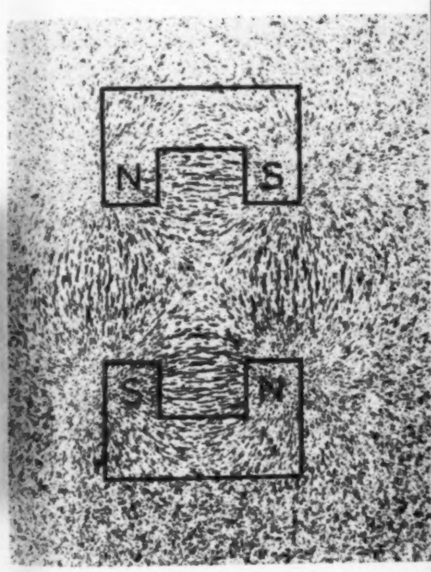


Fig. 6—Left—Magnetic-field distribution map obtained with iron filings for a single permanent magnet

Fig. 7—Above—Flux-density map for a single permanent magnet assembled behind the stationary contact



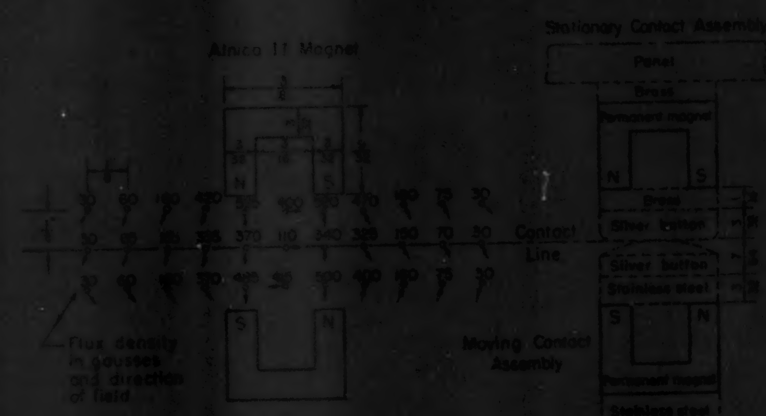
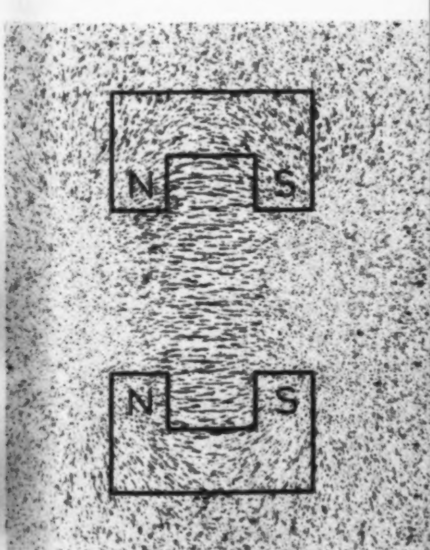


Fig. 8—Left—Iron-filing magnetic-field distribution map for permanent magnets assembled on both the stationary and moving contacts. Magnets are positioned so that opposite poles are in series

Fig. 9 — Above — Flux-density map for two magnets arranged so that opposite poles are in series



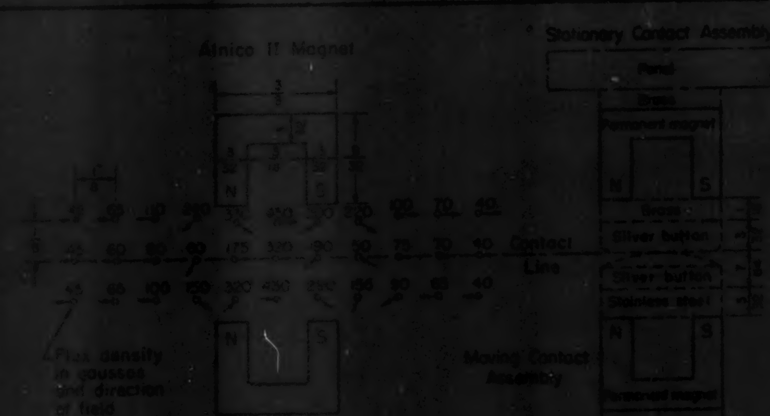
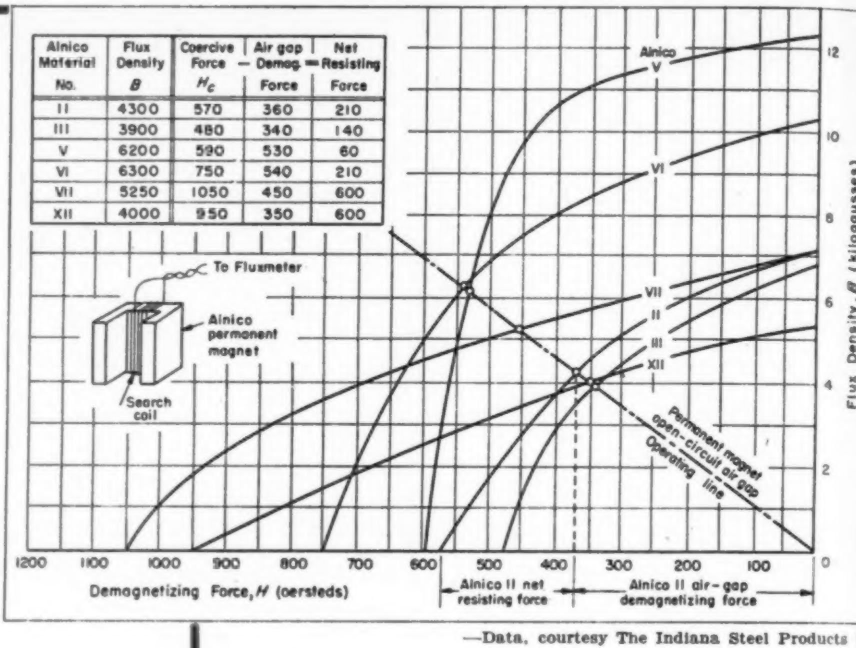


Fig. 10 — Left — Magnetic-field distribution map for permanent magnets assembled on both the stationary and moving contacts. Magnets are positioned so that like poles oppose each other

Fig. 11—Above—Flux-density map for two magnets arranged so that like poles oppose each other



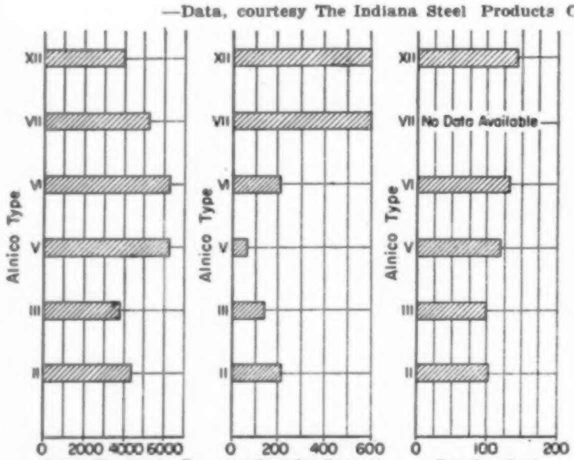
Alnico Material No.	Flux Density B	Coercive Force H_c	— Air gap Demag. Force	= Net Resisting Force
II	4300	570	360	210
III	3900	480	340	140
V	6200	590	530	60
VI	6300	750	540	210
VII	5250	1050	450	600
XII	4000	950	350	600

—Data, courtesy The Indiana Steel Products Co.

Fig. 12—Right—Comparison of various Alnico magnet materials with respect to open-circuit air-gap operating point

Fig. 13—Below—Comparison of flux density, net resisting force against demagnetization, and relative cost for various grades of Alnico permanent magnets

—Data, courtesy The Indiana Steel Products Co.



for welding a solid silver button to brass will often split a brass that has lead in it. Steel backed buttons in magnetic blowout fields are not satisfactory for this application because the steel backing will shunt out an appreciable number of flux lines. A solid silver button is brazed to the nonmagnetic stainless-steel moving contact support. As the magnets are located directly behind the contact buttons and as close as possible to the contact meeting lines, the leakage flux of the permanent magnets is effectively utilized in extinguishing the arc.

Magnet Materials: In *Fig.* 12 the magnetic characteristics are compared for several different types of Alnico magnet materials. With a fluxmeter the density at the center of the magnet can be determined readily. When the search coil is quickly slipped off of the magnet, the fluxmeter will indicate the total number of lines. Dividing this value by the

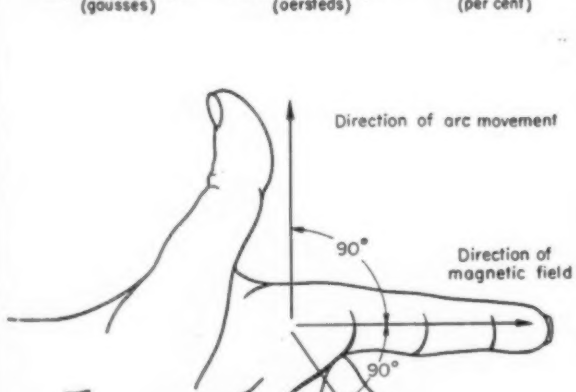
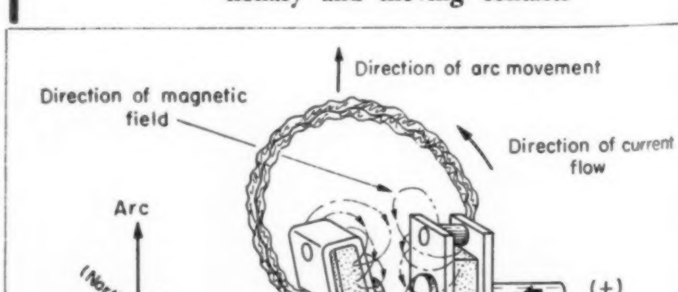


Fig. 14—Fleming's left-hand rule for the motion of an arc or conductor in a magnetic field for a given direction of current flow

Fig. 15—Relationship betwen the arc movement, direction of current flow, and the magnetic field for a switch unit with permanent magnets on both the stationary and moving contacts



magnet cross-section area in square centimeters will give the flux density in the center of the magnet. The magnetic circuit is determined by the geometry of the magnet and, as these particular magnets are used open circuited, the air-gap line will readily show the net force available for resisting demagnetization. The table in the upper left-hand corner of *Fig.* 12 provides a comparison between the flux densities and the net resisting forces for six grades of Alnico magnet material.

While Alnico V magnets have the highest residual flux value, this material is not too suitable for applications where there is an appreciable air gap in the magnetic circuit. However, when Alnico V magnets are applied in a magnetic circuit that has a relatively small air gap, this material is superior to all other grades. For open-circuit applications, and in the region intersected by the air-gap operating line shown on *Fig.* 12, the slope of the *B H* curve is very steep. The air gap is equivalent to a demagnetizing force and, in this particular example, very little additional demagnetizing force is required to reduce the flux to zero. *Fig.* 13 gives a graphical comparison of the flux densities *B*, net resisting forces *H* in oersteds towards demagnetization, and the relative costs of the various grades of Alnico.

For economical reasons and practical manufacturing purposes, Alnico II was selected for magnetic blowout applications. It provides a relatively good field strength and has rather good characteristics for resisting demagnetization. Its cost is only slightly higher than the least expensive grade of Alnico that could be used.

Alnico III has the lowest cost, but its resistance towards demagnetization and its field strength are lower than those for Alnico II.

Although Alnico V magnets have a very high field strength, this excellent characteristic is nullified by their extremely poor resistance to total demagnetization. As indicated in *Fig.* 12, a very low demagnetizing force from another permanent magnet, current flowing in a conductor or electromagnet, or a stray field might seriously impair its field strength.

Alnico VI would be an excellent material for this application as it provides the highest field strength of all the materials considered and has considerable resistance to demagnetization. Its main disadvantage, however, is that it costs considerably more than the other grades that have proved suitable.

Alnico VII would be the best material for arc extinguishing because of its high field strength and superior quality for withstanding demagnetization. However, it is one of the magnet materials that is either cooled or heat treated in a magnetic field. Only its relatively high cost renders it unsuitable.

Alnico XII would also be excellent material for this purpose except for its relatively high cost.

Magnetic Arc Blowout: The basic relationship between the movement of an arc with respect to the direction of the current flow and the direction of the magnetic field is shown in *Fig.* 14. This relationship, known as Fleming's left-hand rule, provides a simple means for predicting the direction of arc movement

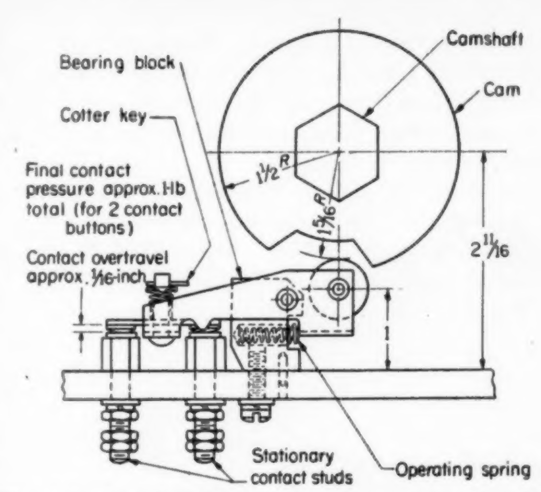


Fig. 16—Standard spring-closed switch unit without blowout means in the normally-closed position and in relationship to the operating cam

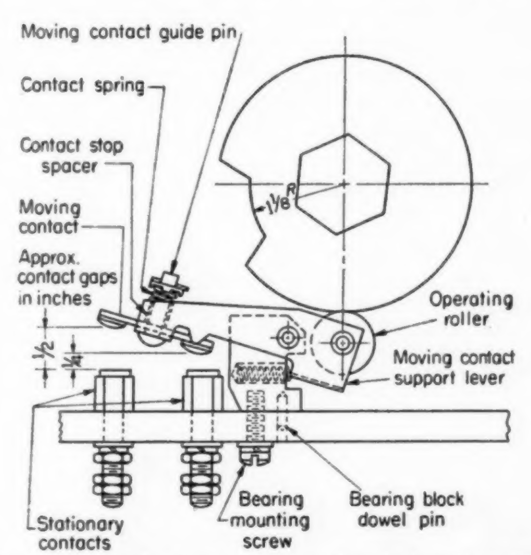


Fig. 17—Standard cam-operated switch unit without blowout means shown in the normally-open position and in relationship to the operating cam

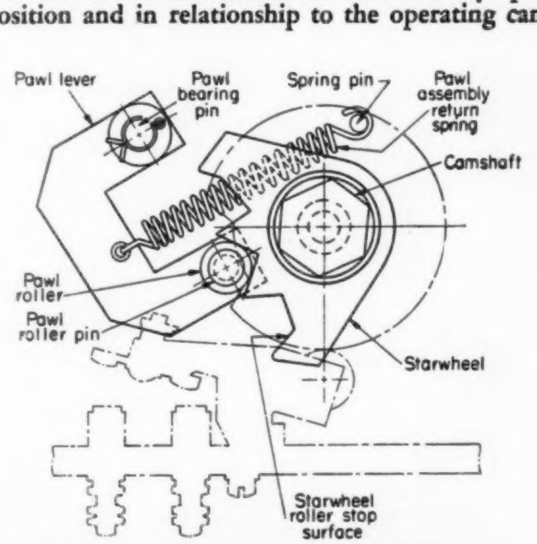


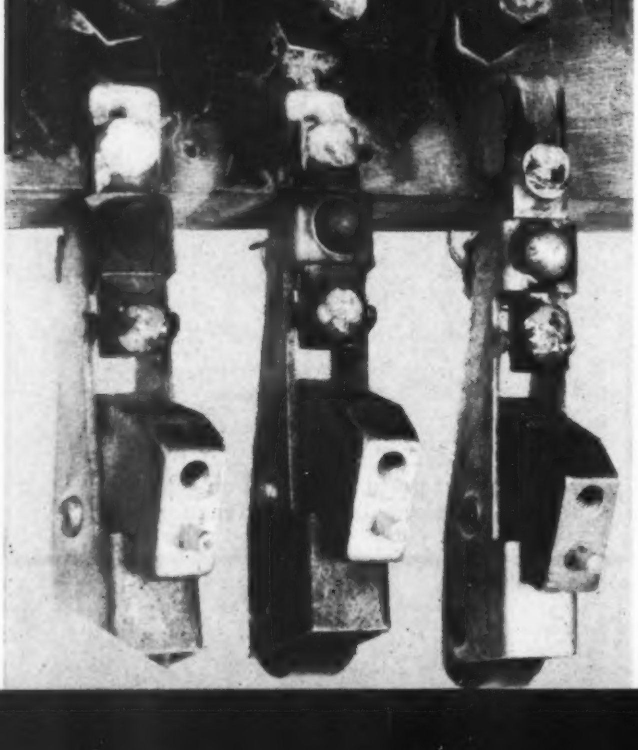
Fig. 18—Starwheel, pawl, and roller assembly for positively positioning the camshaft of a manually operated master switch

in devices with blowout fields and separating contacts. *Fig.* 15 illustrates how Fleming's left-hand rule can be applied to a switch. The upper stationary contact stud is always connected to the positive side of the circuit, so that the arc will always be blown upward and away from the switch parts, thereby avoiding possible damage.

The mechanical design of this switch assembly is such that the upper contact always opens slightly ahead of the lower contact. With permanent magnet blowouts on both the stationary and moving contacts, the arc will be blown upward when the upper contacts separate far enough to draw an arc. Often the arc is extinguished at the upper contacts before the lower contacts have actually opened. For relatively high currents and very inductive circuits, the arcing time is slightly longer. Under these circumstances, a short arc may be drawn between the lower contacts. However, it is generally of such short duration that little or no damage is done to the lower contact surfaces.

As illustrated in *Fig.* 15, the arc will rapidly run up the contact supports and as far away as possible from the contact buttons. This arrangement makes it possible for the arc to first run up the moving contact support and then down the back side to stretch the arc out to a greater length.

Fig. 19—Comparison of switch units (*a*) without blowout, (*b*) with permanent magnet blowout on the stationary contact only, and (*c*) with permanent magnet blowouts on both the stationary and moving contacts after 1,030,034 operations in a highly inductive magnetic contactor coil circuit. The contacts closed and opened a 1.8 ampere load in a 230 volt dc circuit



Mechanical Design: An individual standard switch unit is shown in *Figs.* 16 and 17. This type of switch is opened mechanically by rotation of an insulating cam machined from a laminated phenolic. This arrangement of cam-opened and spring-closed operation is superior to cam-closed and spring-opened assemblies because the cam can apply a relatively high opening force to the moving contact arm assembly should the contacts weld or stick closed. This would not be true for spring-opened switches. For a typical master switch assembly, the total contact separation for the two gaps in series is about ¾-inch, *Fig.* 17.

In *Fig.* 18 is shown a typical starwheel, pawl, and roller assembly for definite positioning of the camshaft at the various operating points. This mechanism holds the operating handle and camshaft in the selected position until the operator moves it to another position. Master switches can also be manufactured so that the operating handle will be spring-returned to the "off" position when released.

Illustrated in *Fig.* 19 are the same three switch units shown in *Fig.* 3 after 1,030,034 closing and opening operations in a highly inductive magnetic contactor coil circuit. Current in the load circuit was 1.8 amperes at 230 volts dc. For this test, a motor driven high speed cam switch was employed to operate the switches successively. The switches were progressively closed and opened on the same inductive load circuit approximately 3000 times per hour.

The silver contact button on the upper moving contact of the left-hand switch without any blowout means, *Fig.* 19, was severely eroded and the silver deteriorated down to the steel backing on the button. The center switch assembly with a single permanent-magnet blowout on the upper stationary contact was in fairly good condition after the test. The right-hand switch assembly with permanent-magnet blowouts on both the upper stationary and moving contacts was in excellent condition when the test was terminated because the standard unit was worn out electrically. It is interesting to note the well defined arc trails on the contact supports of the right-hand switch unit.

The most striking comparison of these three assemblies can be drawn from the amount of carbon deposited on the slate base. There is a dense carbon deposit around the left-hand unit slightly less around the center switch unit, and practically none around the stationary contacts of the right-hand unit.

Because of the extremely severe arcing between the contacts of the standard switch unit, phenolic or ebony asbestos bases were not satisfactory in this test set-up. These bases would carbonize rapidly and arcing would occur over the base surface and between the stationary contacts as soon as voltage was applied to the switch or after the contacts opened. A slate base proved best because of the severe arcing.

A substantial number of these magnetic blowout units have been applied to master switches and motor-operated rheostats during the last several years. They have given excellent service and have been particularly useful in prolonging contact life on slowly operated master switches and rheostats by minimizing contact burning.

TITANIUM CARBIDE

. . . a new heat-resistant lightweight material

By Benjamin L. Hummel
Associate Editor
Machine Design

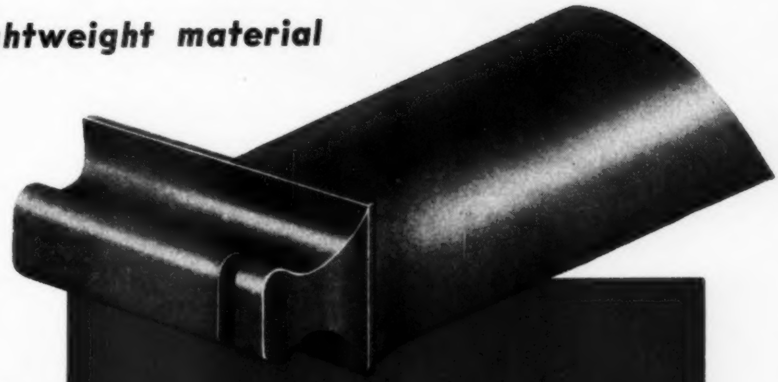


Fig. 1—Cemented titanium-carbide blade for gas turbine. Suitable for service to at least 2200 F, this blade is machined before final sintering. No further work is required on the foil, although the root is ground to final dimensions after sintering

HIGH-TEMPERATURE service places perhaps the most severe demand upon the performance of engineering materials. A reasonable degree of mechanical strength must be retained at the high temperature, oxidation must be slight or nil, while still other properties required in a part and its fabrication must be inherent in the material.

Need for heat resistance has been most dramatically accentuated, of course, by such developments as the jet engine, the gas turbine and various AEC projects. Jet engines, for example, could not be developed until suitable heat-resistant materials were first available. Even now, a temperature increase of several hundred degrees in the safe limit of a material means more than a merely proportionate boost in performance or service life.

As the high-temperature frontier advances under the impetus of such demands, advantage can well be taken of improved materials in the design of more prosaic but none the less essential equipment.

A relative newcomer in this field, titanium carbide holds promise of setting a new high in temperature limits for parts in a wide variety of applications. It is a member of the cemented-carbide family. This group is perhaps most commonly identified by tungsten carbide which 15 years ago revolutionized cutting tools, dies, etc., and has also been used effectively for machine components requiring high wear resistance.

Titanium carbide, developed by Kennametal Inc. under the trade name Kentanium, has been available for experimental purposes over the last three years. Before then, it was known to metallurgists but methods for its successful production had not been worked out. Produced by powder metallurgy techniques, it is a titanium-carbide base material with nickel serving as the auxiliary or binder material. Cobalt had been used earlier for this purpose but nickel was since found to offer superior high-temperature properties.

Properties: With respect to its properties, cemented titanium carbide might best be described as a cross between tungsten carbide and the superalloys with some traits distinctive to it alone. Its properties are

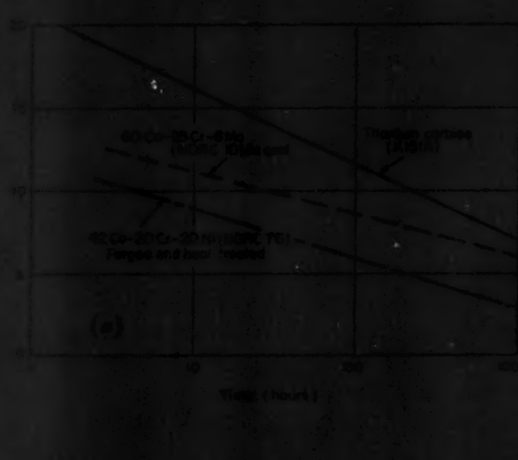


Fig. 2—Stress rupture curves, *a*, for two high-temperature alloys and a titanium-carbide grade at 1800 F. At *b* the strength-weight ratio characteristics are shown for the same materials

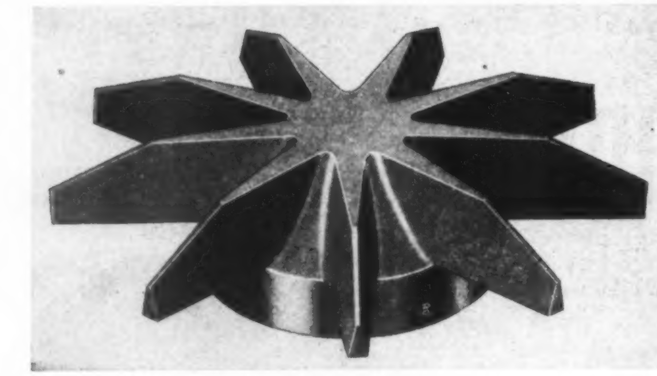


Fig. 3—Cemented titanium-carbide impeller plate for an inward flow turbine now in test cell operation. Current experimental aim of this development, already surpassing conventional designs, is a tip speed of 1000 fps at 2200 F

compared to those of the latter materals in TABLE 1.

These data point up some features of significance to the designer. The density of the material is one-third to one-half that of tungsten carbide, about two-thirds that of the superalloys. This property is of particular advantage, of course, in rotating or reciprocating parts where inertia stresses are proportional to weight, *Fig.* 1. Hardness typical of the cemented carbide family means wear resistance. Deflection under a given load would be only about one-half that of ferrous materials because of the high elastic modulus. The relatively high thermal conductivity of titanium carbide and its low thermal expansion are factors in its resistance to thermal shock and its adaptability to diversified high-temperature applications. Its oxidation resistance, which varies according to grade, stems from a thin, tenacious oxide coating. Of particular value is its strength at elevated temperatures.

Strength at high temperatures is perhaps better demonstrated by stress-rupture data which relate stress, temperature and time to rupture. Such data are shown in *Fig. 2a* for several materials at 1800 F. The gain is pronounced in terms of allowable stress and perhaps even more significant in terms of expected life. *Fig. 2b* shows in effect the corresponding strength-weight ratios, which are of fundamental concern particularly for rotating or reciprocating components.

Carbides are usually considered to be low-ductility materials, and titanium carbide fits this classification. It does, however, possess enough ductility to suit many applications denied tungsten carbide. Tests made to date show its stress-rupture elongation at 1600 F is about 2 per cent and slightly greater at high temperatures. This factor has not been a handicap in those applications where it has been taken into account in design.

Processes: The basic procedure in the production of titanium carbide is ball milling of the metal powders, pressing of the mixture to a shape approaching that desired in the finished part, further shaping with or without presintering, and final sintering in the absence of air. During this latter step, shrinkage of 18 to 20 per cent occurs.

In many cases the parts can be machined after presintering, with no great difficulty to limits close enough to obviate grinding after final sintering. By proper allowance in the presintered part, final dimensions can be held within 1 per cent through sintering despite the large shrinkage. Foils of blades such as shown in *Fig.* 1 need no final grinding after sintering, although the root is ground to finished size because of the critical fit required.

Shaping of the presintered slugs is usually performed by existing machining methods. Diamond-tipped tools are usually employed, and instead of milling cutters, abrasive wheels are used. Complex shapes such as the turbine impeller shown in *Fig.* 3 are formed with abrasive wheels.

Such parts as turbine blades and nozzle vanes are machined in large lots on multiple-head automatic tracer millers prior to final sintering. Experiments to date indicate that the material can be extruded and, under certain conditions, pressure formed.

Design: No detailed rules have yet evolved for designing with titanium carbide. Certain general rules are dictated by the properties of the material, and these will be amplified as more experience is accumulated.

Conventional design procedures with more ductile materials must be reviewed and altered for titanium carbide. High modulus of elasticity and low ductility must be recognized. The effect of stress concentrations is much more acute than with most engineering metals. For example, titanium-carbide blades tested by NACA failed because of the use of a pine-tree root

Table 1—Comparative Physical Properties*

Property	Titanium Carbide	Tungsten Carbide	Superalloys
Density (gm per cc)	5.5–6.5	11.9–15.1	8.3–8.7
Hardness (Rockwell A)	83–93	85–93	61–65
Modulus of Elasticity (1,000,000 psi)	55	61–90	30
Compressive Strength (1000 psi)	550	518–800	.....
Thermal Conductivity (cal/deg C/cm/sec)	0.075–0.085	0.068–0.207	0.035–0.065
Electrical Conductivity (per cent Cu standard)	1.9–5.0	4.3–9.4	1.37–1.8
Thermal Expansion (0.000001 cm/cm/deg F at 1200 F)	4.5–5.0	2.5–4.0	6.73–8.5
Oxidation Resistance (at 1800 F)	Excellent	Poor	Good
Tensile Strength (1000 psi)			
70 F	80–120	.....	110–180
1500 F	55	.....	52–73
1600 F	47	.....	34–51
1800 F	40	.....	9–25.5
2000 F	30	.....	13.1
2200 F	12.5	.....	.....
2400 F	3	.....	.....

*Data for the three types of materials are composite values. Nickel, ranging from 10 to 30 per cent, is the auxiliary metal for the titanium-carbide compositions.

which had been successful with one of the more ductile superalloys. Designed in place of the serrated construction, a bulb-type root has improved the operating life.

On the other hand serrated roots in large blades have functioned successfully because relatively large radii could be incorporated. Hence, large radii and other stress relieving means must be specified to obtain the maximum potential of the material.

Titanium carbide can be joined by brazing but mechanical joints are preferred. For service at extremely high temperatures, mechanical joints are mandatory.

When severe thermal shock is anticipated, section thicknesses should be as uniform as possible.

Various processes available in the forming of the part must be considered in design. In general, if conventional machining procedures are kept in mind, a part can be produced which after sintering will be within 1 per cent of the specified dimension. However, if certain details require a high order of precision, say 0.0001-inch, such details must be adaptable to grinding or lapping after sintering.

The large shrinkage factor may impose some modifications upon conventional concepts in design. Geometry of ribs, for example, must anticipate shrinkage.

Extruded shapes might well be utilized. Developments are still continuing in this direction, but extrusions have been proved practical and are available in various shapes and sizes.

Applications: Although its period of development is short, titanium carbide has established a number of successful applications. Its primary utility is suggested, of course, by its resistance to heat, thermal shock, oxidation, wear, and relatively light weight. Turbine blades and nozzle vanes for jet engines are perhaps the most significant current applications of titanium carbide. Further advances in this field of application can be anticipated with adequate cause.

Another developing application is valves and valve guides for reciprocating engines, *Fig.* 4. Titanium-carbide valves tested in high-performance aircraft engines show marked superiority over sodium-cooled alloy valves. Besides functioning without sodium cooling, the carbide valves display excellent resistance to wear and corrosion under abnormally severe service conditions.

Titanium carbide can also be used effectively in any application normally suited to tungsten carbide with the exception that heat is excessive. Thus, hot spinning tools, hot forging dies, tools for trimming flash from welded tubes, etc., are appropriate applications. In this same sense, titanium carbide is being used for sealing rings and bearings in high-temperature environments.

An application requiring wear resistance is encountered in oil wells—ball and seat check valves. Service life under repetitive impact has been prolonged by the use of titanium carbide in place of much heavier tungsten carbide. Titanium carbide is also being used for wear-resistant parts in some

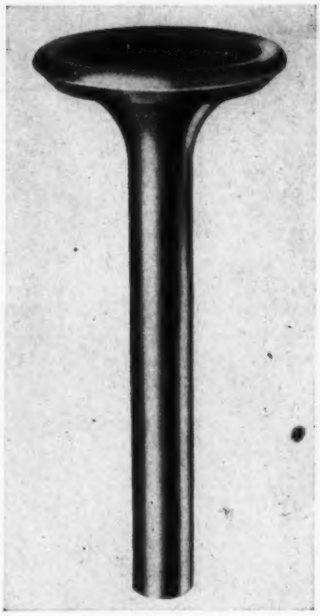


Fig. 4—Exhaust valve for reciprocating military aircraft engine. Take-off overload conditions sustained for 16 hours produced no measurable wear on the valve stem or seating area

applications where other equally hard materials failed because of brittleness.

A pressure reaction vessel has been successfully fabricated to withstand an internal pressure of 30,000 psi at 2300 F. Under similar conditions conventional metallic materials suffer plastic deformation.

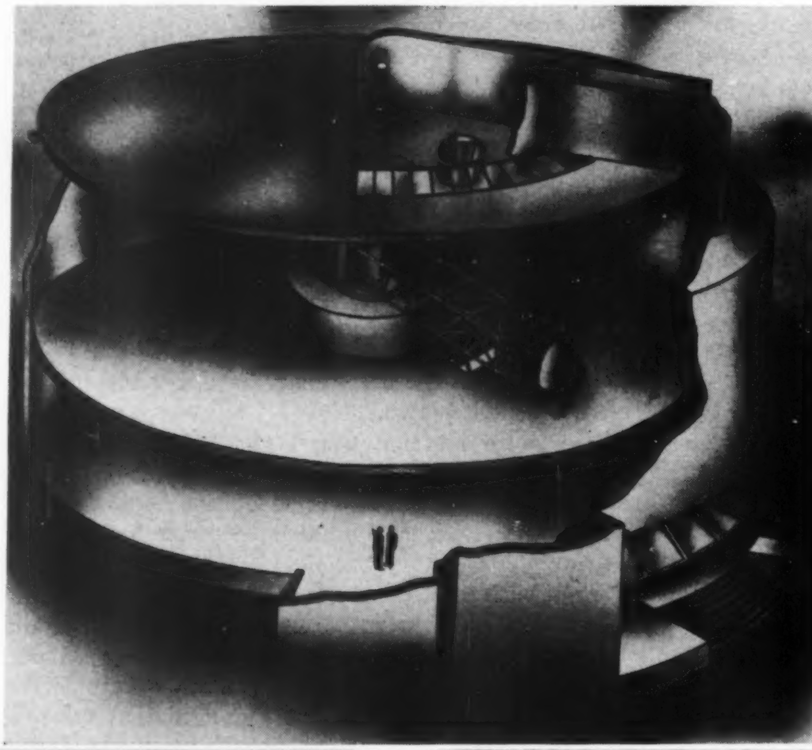
Conservation: One of the most important possibilities offered by titanium carbide is the conservation of strategic materials. A maximum of about 30 per cent nickel by weight, cemented titanium carbide requires only about 25 per cent nickel content relative to a superalloy part of comparable size. In high-temperature service this percentage might be still lower on a comparative basis—thinner sections might be employed because of higher strength. It requires little or no columbium, cobalt, molybdenum or other of the elements which are likely to continue in short supply indefinitely. Its principal ingredient, titanium carbide, is relatively abundant.

Future Developments: Research now in progress indicates that the temperature limits and strength properties here reported will be further improved. Exposure to temperatures as high as 4500 F has been tried. In this range, despite the presence of the auxiliary metal, the material becomes plastic but does not melt. The safe high-temperature range of new compositions being developed is likely to be at least several hundred degrees above the accepted current range of 1400 to 1600 F. Or, in the current range, strength can possibly be doubled.

Another prospect in the future of titanium carbide is the development of compositions which will be comparable in high-temperature strength to the superalloys but which will use no strategic elements. Advance work shows that chances of success in this direction are quite favorable.

Co-operation of the following personnel of Kennametal Inc. in the preparation of this article is gratefully acknowledged: John C. Redmond, S. A. Oviatt, J. Graham, J. R. McVeigh, E. N. Smith, and Floyd Gerard.

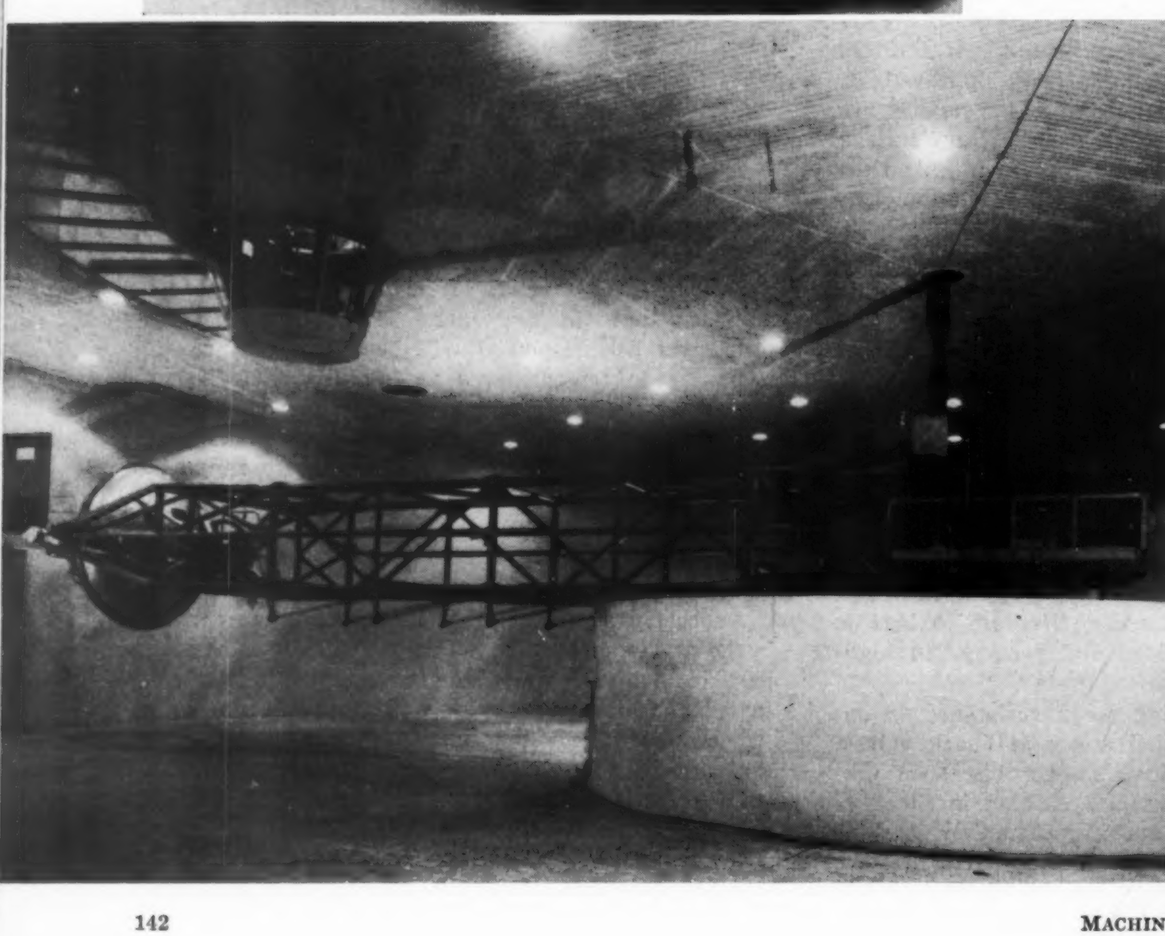
CONTEMPORAR
DESIG



Centrifuge Simul

EVALUATIVE tests to determine human tolerances with respect to extreme accelerations encountered in sonic-speed aircraft will be laboratory-conducted with the world's most powerful human centrifuge, left. Built for the Navy by the McKiernan-Terry Corp., the centrifuge has a 50-foot arm, below left, driven by a 4000-hp General Electric dc vertical motor weighing 180 tons.

Human test subjects ride in an oblate spheroid gondola, below, mounted on trunnions within a gimbal ring at the end of the arm. The new testing machine is capable of accelerating the "test pilot" from a dead start to 90 mph in 1½ seconds, and to 174 mph in

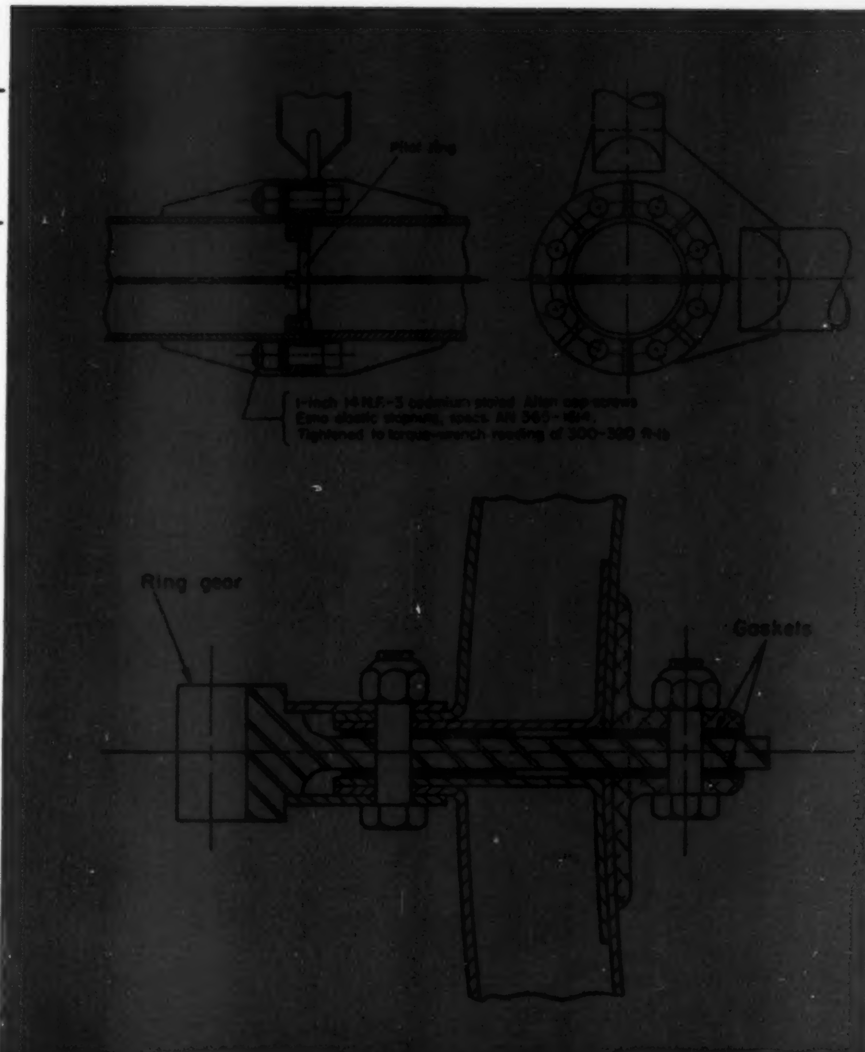


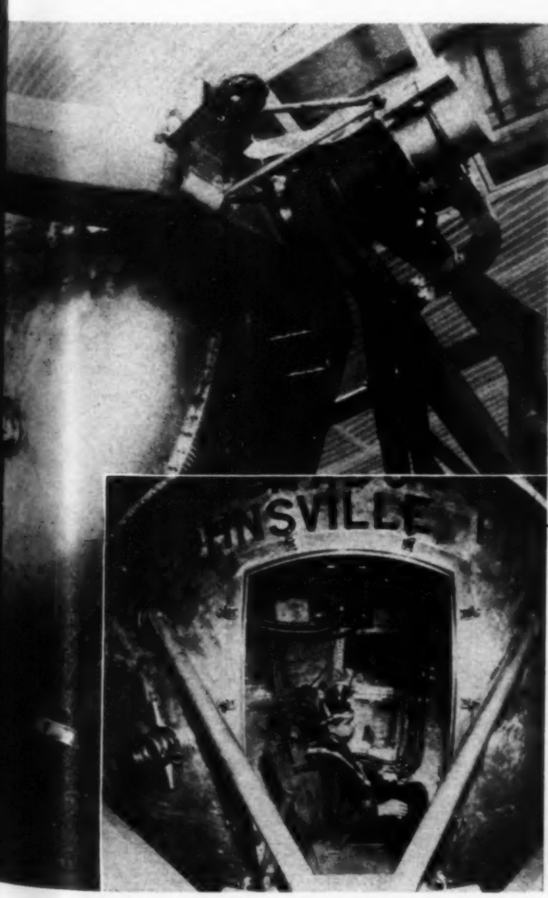
Accelerations

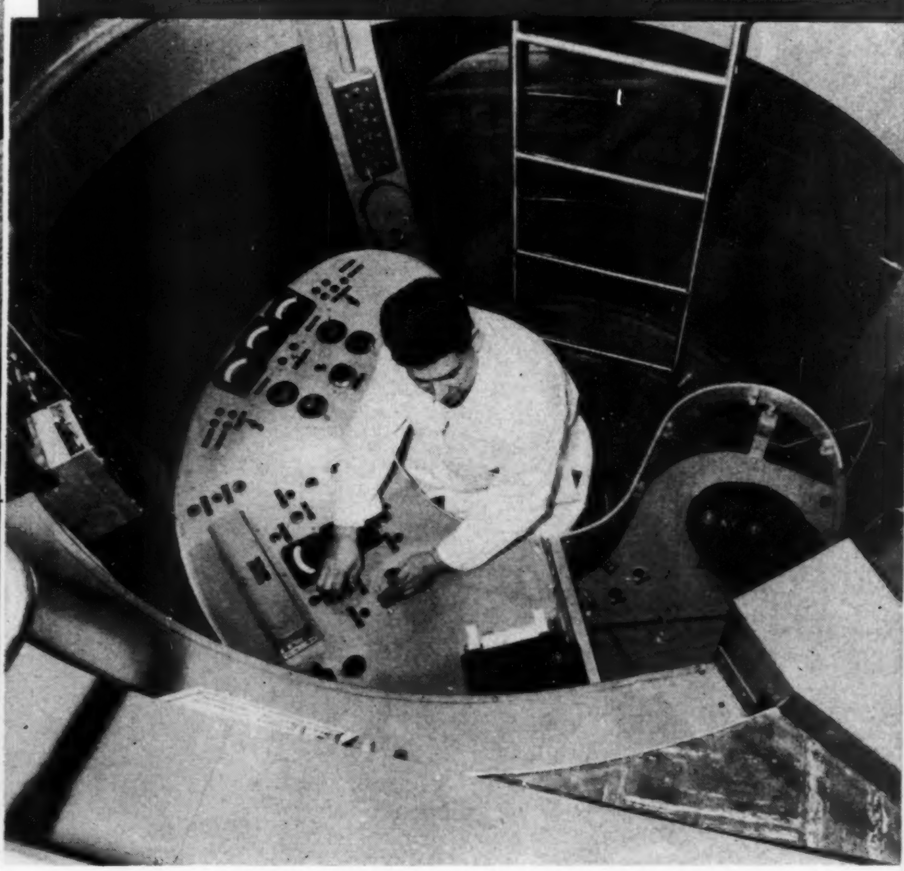
less than 6.9 seconds. At this speed, 48.6 rpm, the huge drive motor will develop 16,000 hp momentarily.

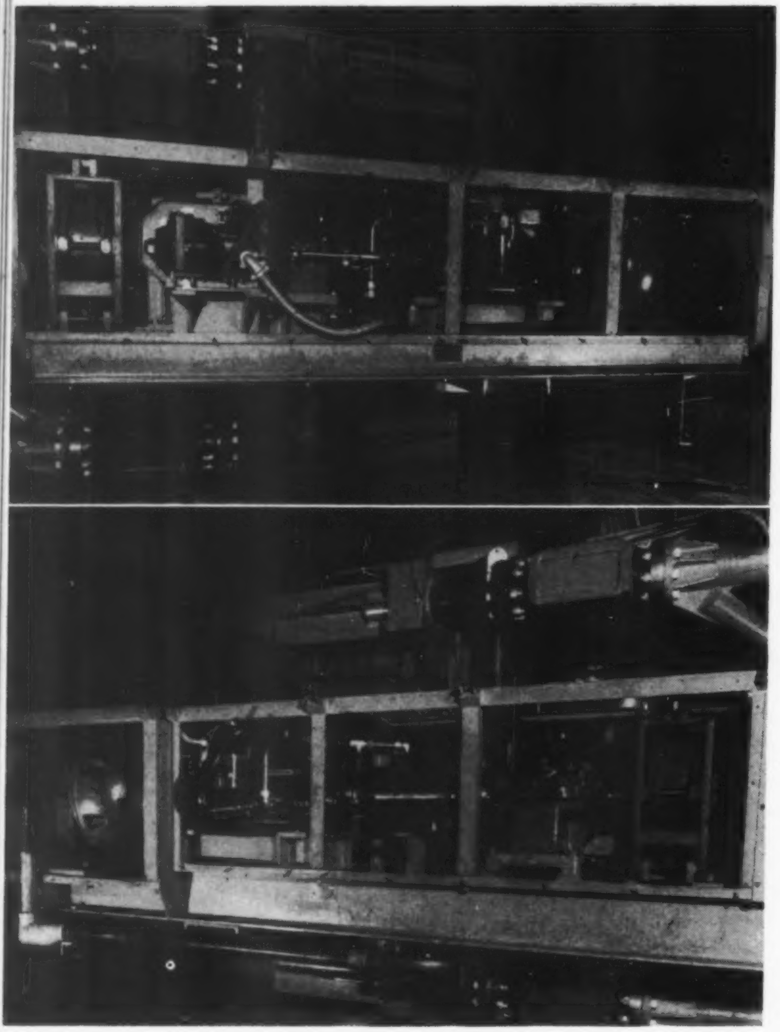
Made up of four prefabricated sections of welded plates and tubes bolted together at machined flange joints, top right, the centrifuge arm is counterweighted and balanced dynamically at the hub mounting. All bolts at these critical joints are prestressed at assembly. Alloy steel bolts are used in combination with Elastic Stop Nuts to maintain the original preloading. Total bolt strength in all joints exceeds the ultimate strength of the arm sections.

Also critical is the bolted seam between halves of the gondola, right. These are of sandwich construction, an inner and outer aluminum skin between which is glued a cellular plastic material. The gondola half shells are bolted together with 10-foot di-









ameter ring gear between them, gasketed to form a vacuum-tight seal. Air pressure and temperature inside the cell are regulated by remote control to simulate flight conditions at altitudes up to 60,000 feet.

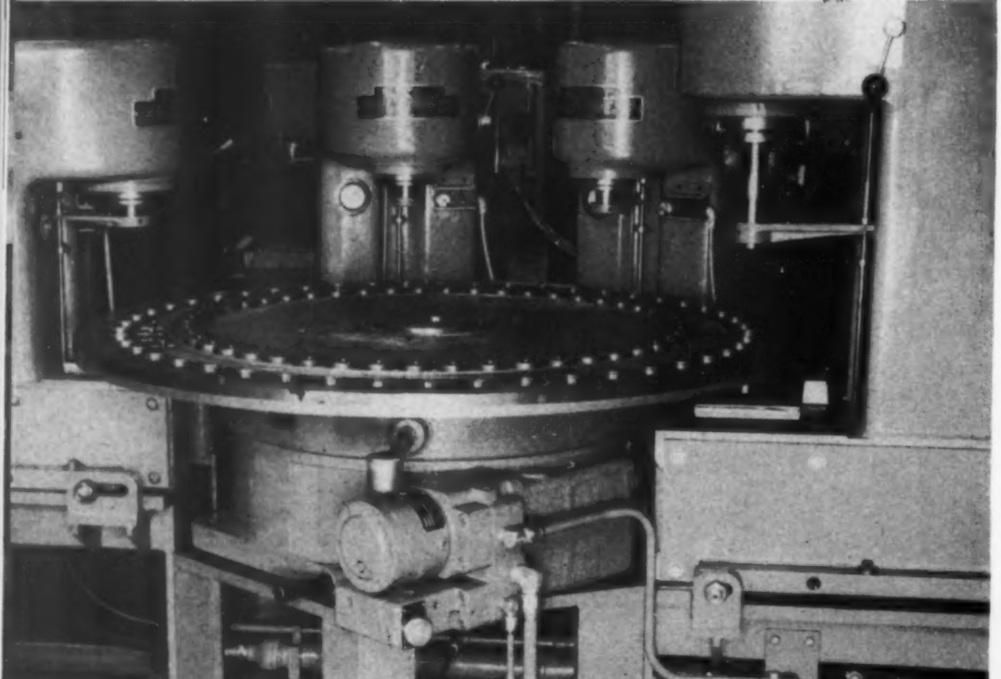
From a control blister in the ceiling above the arm, bottom right, previous page, the gondola may be positioned universally while the centrifuge is in motion. Repetitive acceleration cycles are controlled by turntable-mounted cams at the control desk, to the operator's left. Speed also can be controlled manually by the operator or by the "test pilot."

Tubular driveshafts alongside the arm connect the gondola positioning drive gears to electrohydraulic power units carried on a platform extension of the arm, left. The drive for rotating the gondola about its minor axis is through a spur pinion which engages the central ring gear of the cell. The gimbal ring is connected by a floating link to a bevel gear sector pivoted at one trunnion of the ring. This sector is driven by a bevel pinion on the other driveshaft.

In addition to physiological sensing devices attached to the body of the test subject, high-speed X-ray and motion picture cameras in the gondola record man's outward reactions to accelerative impulses. Constant watch is maintained over the "test pilot" through the facility of a closed television channel with camera mounted in front of him in the gondola.

Television, control and recording circuits are coupled to the "stationary world" through a collector ring assembly carried on an extension of the main motor shaft. In the Aviation Medical Acceleration Laboratory of the Naval Air Development Center, Johnsville, Pa., the human centrifuge will also perform acceleration tests on aircraft equipment.

Hydro-Geneva Drive Indexes Table



GROUPED around a 60-inch, 12-station Denison automatic indexing table, left, four hydraulic Multipresses perform mass production assembly operations rapidly. Heart of the rotary drive is the Geneva mechanism, next page, which is driven by fluid motor through a worm gear drive. When in indexed position, the table is locked by a sliding key. This key engages one of the wheel slots provided primarily for receiving the Geneva driver pin. Table positioning is thus made more accurate than the Geneva mechanism itself would provide because of practical working clearance requirements.

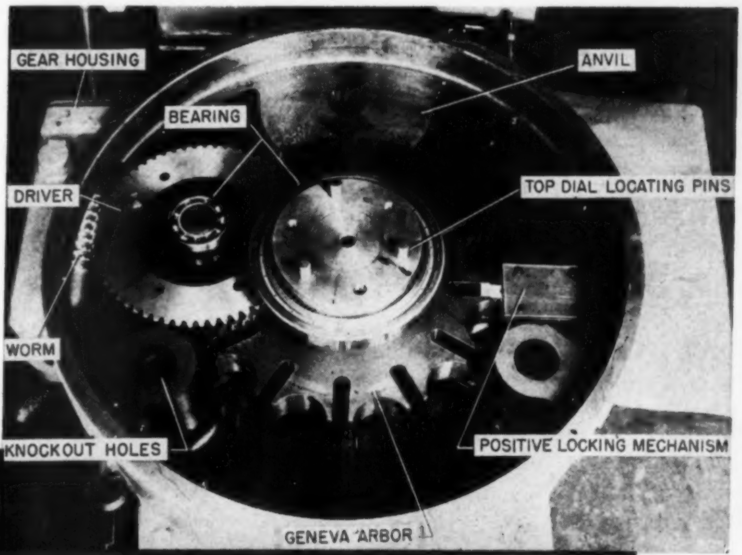
An eccentric on the wormwheel shaft synchronizes the sliding key motion with the index drive. Hydraulic power from one of the press units is utilized to drive the hy-

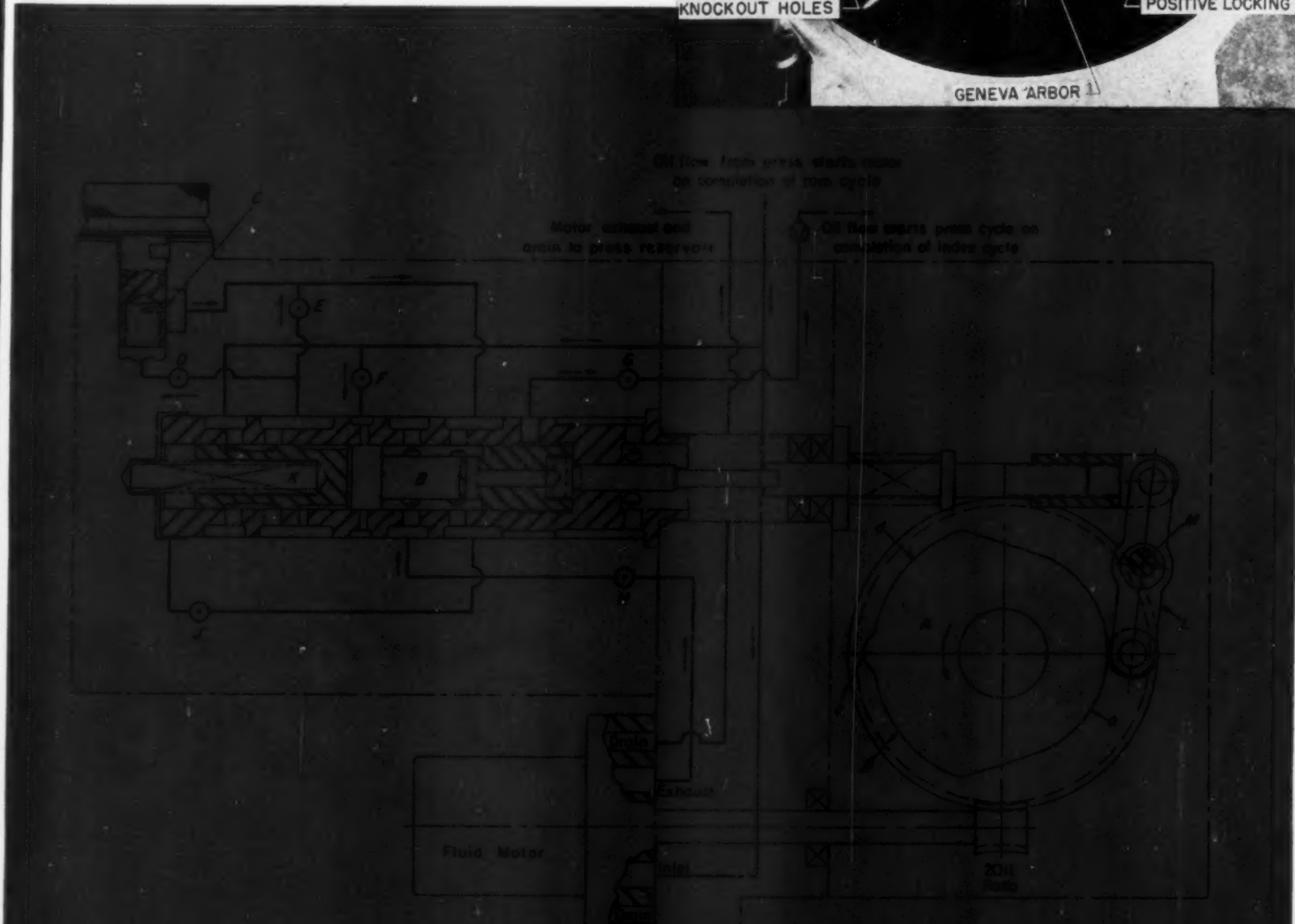
draulic motor. On completion of all press strokes, series limit switches mounted on the press columns initiate the index cycle automatically by admitting oil to the motor circuit.

Referring to the accompanying schematic diagram, cam *A* (keyed to the Geneva driver and the lock eccentric) controls the index cycle. Four cam levels *a, b, c* and *d* produce the following functions, respectively, through control of sequence valve *B:* (1) table indexing at selective speeds between maximum and zero as determined by the setting of throttle valve *C*, the control range of which is spread by series orifice *D;* (2) fast motor rotation to lock the table after the Geneva driver has disengaged; (3) blocked motor exhaust causing pressure relay through the motor exhaust circuit to start the press cycle; and (4) resumption of fast motor rotation for rapidly unlocking the table and engaging the Geneva driver on signal of press cycle completion.

To limit top indexing speed, part of the motor oil supply is by-passed to exhaust through orifice *E*. Orifices *F, G* and *H* serve to cushion motor acceleration and deceleration while *J* produces dashpot effect in operation of the spring-returned flow control valve *K*. Index stations may be skipped through auxiliary control of the sequence valve rocker arm, *L,* pivoted on an eccentric-mounted fulcrum pin, *M*. When rotated anticlockwise by a skip cam on the table, the fulcrum pin prevents valve motion normally produced by the cam's highest point. Rotation, therefore, continues to the succeeding station.

Direction of table rotation may be reversed simply by removing four cap screws and shifting the motor flange around 180 degrees on the mounting pad. No piping changes are necessary.



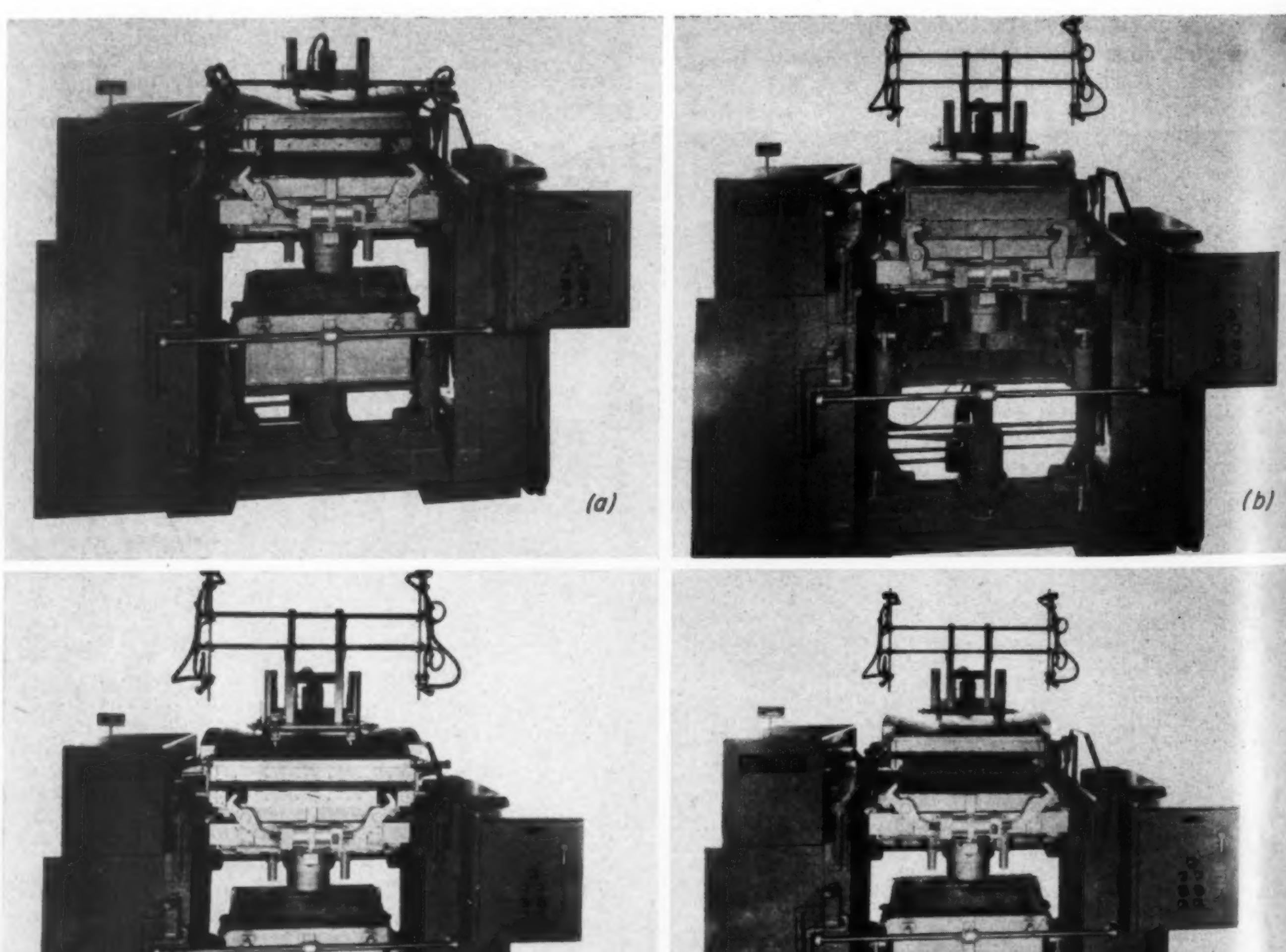


Molder Eliminates Human Variables

CONTROLLED production of shell molds is possible in the new Sutter rollover machine designed to meet most present-day shell-molding requirements. Since most shell molding thus far has involved specially built machinery and a high percentage of manual skill, this machine was developed to overcome two major shell-molding handicaps; high labor cost and inconsistent mold quality.

Operable in fully adjustable automatic cycle, the new machine, series of photos below, is completely independent of operator skill. Metal patterns containing built-in heating elements are mounted on a trunnion-supported platen between the machine uprights. Photo *a* shows step one of the cycle where overhead spray guns swing down into position and spray the pattern with a mold release agent. Then the guns retract to inoperative position and the platen is rolled over. A bin of powdered resin cradled on elevating rollers below the platen is raised close to the face of the inverted pattern. Powered by a pair of opposed pistons at front and rear of the platen, four cam levers engage pin extensions on the bin, clamping it securely to the platen which then rolls back to its original position, photo *b*. Powdered resin from the bin melts and coats the pattern surface after which the bin is returned to its cradle and the platen reassumes upright position. Rolled forward on inverted V-rails, the front end being lifted by outboard roller contact with auxiliary rails, an oven is positioned for curing the fully coated pattern, photo *c*.

On completion of the curing cycle, the oven retracts and multiple stripper pins raise the shell clear of the pattern, photo *d*. Machine cycle time for producing a mold is 33 seconds plus the required coating and curing time. These cycle phases are preset timer-controlled periods according to pattern characteristics.



Polygonal Action in CHAIN DRIVES

A fresh approach to an old problem gives an accurate picture of output velocity and acceleration in roller chain drives

By Ralph A. Morrison

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MACHINE designers and engineers generally recognize that the smoothness and quietness of a roller chain drive, *Fig.* 1, depend largely upon the number of teeth in the driving and driven sprockets. However, they may not realize just how sprockets of small numbers of teeth affect the motion of the output shaft and how to minimize this effect for a given combination of sprockets.

When a chain engages a sprocket, each link falls on a chord of the sprocket pitch polygon and not on a pitch circle. Therefore, the active pitch diameter of the sprocket varies between the limits of a circle inscribed in the pitch polygon and a circle circumscribing the pitch polygon. The difference between these diameters decreases asymptotically toward zero as the number of teeth in the sprocket approaches infinity. Unless the drive is of one to one ratio, and the center distance and tangent span are equal to a whole number of pitches, this condition of varying radii is conducive to output-shaft pulsation. Hence, the chain is subjected to a series of acceleration loads which often causes excessive noise, vibration, and premature chain fatigue failure.

Several interesting approximations have been made of the driven shaft angular velocity characteristics caused by the polygonal effect of sprockets. But close examination of the chain drive components shows that the motion is actually transmitted through a series of four-bar linkages, *Fig.* 2. To illustrate the action of such four-bar linkages as applied to chain drives, the kinematics of output shaft motion with progressively larger sprocket combinations under various center distance conditions will be discussed in this article. Each motion curve, *Fig.* 3, has been calculated by previously established methods.[1,2,3]

It should be understood that this analysis in no way makes provision for the elasticity of the chain and mountings, chain length tolerance and inaccuracies of the sprockets. Actually, the connecting link in these linkages is a section of chain, and as such cannot transmit a decelerative force to the driven mass. Furthermore, weight of the chain, particularly in horizontal drives, coupled with the effect of the dissi-

[1] References are tabulated at end of article.

pation of rotational energy as the chain leaves the driven sprocket, prevents this connecting span from ever becoming a straight line. However, for a moderate work load, this span becomes, for all practical purposes, a straight line and is assumed to be such in the following analysis.

Only if the resisting torque exceeds the maximum deceleration torque will the velocity of the driven shaft follow the complete velocity cycle shown in *Fig.* 3. When the deceleration torque exceeds the resisting torque, the driven shaft will tend to coast ahead of the driving chain, thereby reducing the total variation in its angular velocity and the amplitude of acceleration force involved.

This fact is a most important consideration in the action of a chain drive. With sufficient flywheel effect in the driven masses to maintain a more nearly uniform angular velocity and provided the normally slack span does not become the driving member, the driving chain will provide only a series of accelerating pulses to the driven sprocket. The intensity of these acceleration pulses depends upon how much effect the resisting torque, chain weight and chain inertia forces, due to surging and whipping action, have on the velocity characteristics of the output shaft.

The surging and whipping of chain in the slack span is a by-product of the polygonal action and the resisting torque is a function of the power transmitted. Therefore, the smaller the ratio of resisting torque to inertia torque in the driven mechanism and the greater the number of teeth in the sprockets, the less the change in output angular velocity and the smoother and quieter the drive will be.

Only in rare instances will the slack span become the driving element and cause the driven shaft to follow through a complete velocity variation. The time required to turn the driving sprocket an amount equal to one pitch is not great enough to allow the driven sprocket, by coasting ahead, to increase the tangent span length in the slack side by more than a few thousandths of an inch.

For the great majority of chain drive problems where loads and speeds are not high and sprockets of a reasonable number of teeth are used, no consideration of polygonal effect is necessary. Once the chain and sprockets have been selected, a center distance is usually calculated to give a snug-fit chain having an even number of chain pitches. When drive conditions warrant consideration of the polygonal effect and the center distance is not fixed by other machine design considerations, the question is: What center distance will minimize this effect and result in the smoothest drive?

It will be shown in the following analysis that the operating center distance has an effect upon the four-bar linkage components insofar as the transfer of load between pitches and the maximum angular acceleration of the driven shaft are concerned. However, the benefit to be realized by using the optimum center distance is small compared to the benefits obtained by an increase in the number of sprocket teeth. In actual practice, unless operating conditions are favorable, the improvement in drive performance at the optimum center distance may be found to be negligible.

Referring to *Fig.* 2, the four-bar linkage conditions are shown for a chain drive under various center distance conditions. Although not practicable, a four-tooth driving sprocket is assumed for the sake of exaggerating the action and better illustrating the linkage components. *Figs.* 2*a* and *c* indicate the drive

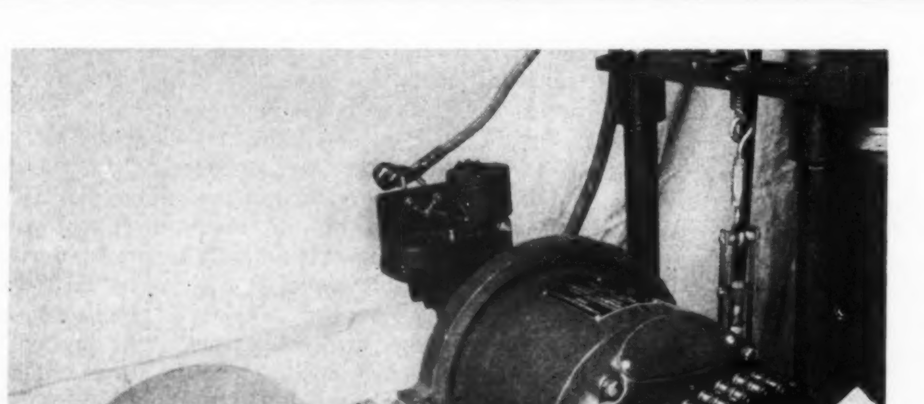


Fig. 1—Dynamometer test setup for observing roller chain action under various load conditions

conditions when the tangent span contains a whole number of pitches and is tangent to the inner and outer pitch polygon circles respectively. *Fig. 2b* indicates the same drive with an odd number of half pitches in the tangent span.

When the center distance between sprockets is such that the tangent span is tangent to the pitch polygon inner circles and there is a whole number of pitches in this span, as shown in *Fig. 2a,* the variation in angular velocity of the driven is at a minimum and the transmission of power between pitches will be, theoretically, somewhat smoother.

Only at this center distance will one four-bar linkage alone transfer the load for one pitch displacement of the driver. As each pitch of the chain engages the driving sprocket, a succeeding four-bar linkage takes over the load and a link of the chain will be dropped by the driven sprocket at the same instant a link is engaged by the driver. For any other center distance, a secondary transfer of load occurs between pitch revolutions of the driver because of a change in the length of connecting link of the four-bar linkage.

This can be visualized readily by referring to the dashed linkage in *Fig. 2c.* If the driving sprocket is revolved until the tangent span lies on a chord of the driving polygon, the tangent span will not lie on a chord of the driven polygon. However, after a few more degrees of motion of the driver, the tangent span will lie on the chord and a pitch of chain will be released to become part of the connecting link. This, of course, changes the motion characteristics of the linkage and results in a sudden change in acceleration of the driven link. Where this load transfer and acceleration change occurs depends upon the deviation from the optimum center distance shown in *Fig. 2a.*

From the geometry shown in *Fig. 2a,* it can be seen that this optimum center distance in inches is

$$C = \sqrt{L^2 - \frac{P^2}{4}\left(\cot\frac{180}{N} - \cot\frac{180}{n}\right)^2}$$

where L = length of tangent span, inches; P = pitch of chain, inches; N = number of teeth in large sprocket; n = number of teeth in small sprocket; and the angles, $180/N$ and $180/n$, are in degrees.

To illustrate the variations in velocity and acceleration for different center distance conditions and to show how rapidly the change in velocity increases with sprockets of small numbers of teeth, the velocity and acceleration curves for various drives have been calculated and plotted in *Figs. 3a* and *b* respectively. In each case the smaller sprocket was assumed to be the driving member. In the event the larger sprocket becomes the driver, the percentage variation in angular velocity of the driven shaft will not change but the actual amount will be considerably greater due to the step-up in shaft speed. Since this can lead to very high accelerative forces in the driving chain, drives of this type should be given particular consideration, especially where small sprockets are involved.

The velocity curves plotted in *Fig. 3a* indicate at any time the ratio between the output and input angular velocities. This ratio varies between extreme values below and above the basic ratio. To clarify and provide a better comparison of this total variation in angular velocity of the output shafts, each curve was plotted to the same amplitude scale and from the same point of origin. The abscissa of these curves is one pitch displacement of the driver or 360 degrees divided by the number of teeth. The angular acceleration curves, *Fig. 3b,* are plotted with the same abscissa as the velocity curves. The acceleration values indicated are in radians per radian squared, which can be changed to a function of time by multiplying these values by ω^2, where ω is the uniform angular velocity of the driving shaft in radians per second. Caution is advised, however, in attempting to apply these values to drives of other proportions, since the motion characteristics of the linkage depend upon the numbers of sprocket teeth, center distance, and pitch involved.

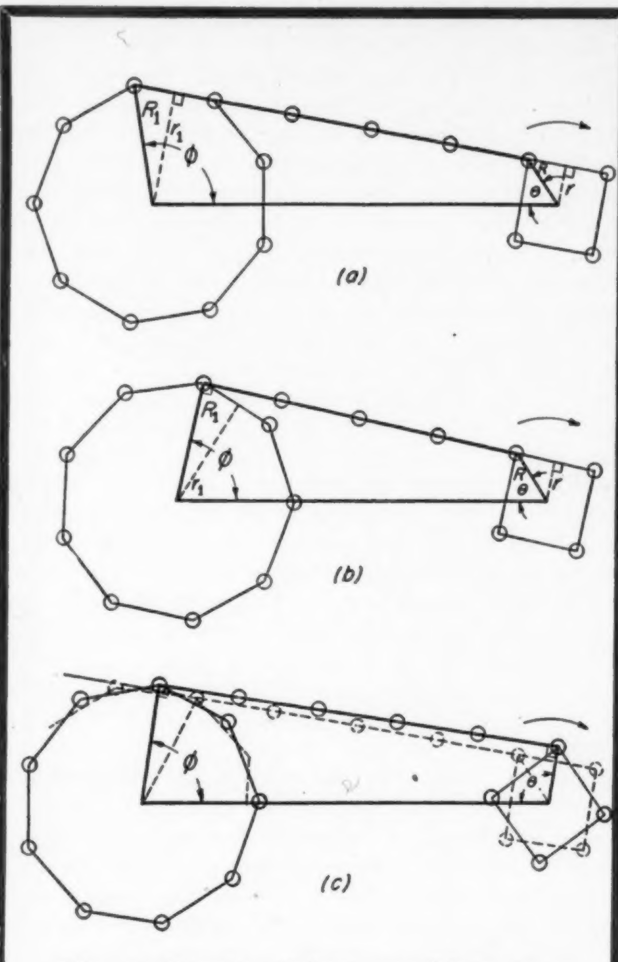


Fig. 2—Four-bar linkage conditions in a chain drive as influenced by shaft center distance and relative angular position of the sprockets

Referring to *Fig. 3,* drive No. 1 was calculated for a driving sprocket of four teeth and a driven sprocket of nine teeth with the tangent span as shown in *Fig. 2b.* It will be noted that the secondary load transfer occurs about halfway through a pitch cycle of the

driver, resulting in a severe change in acceleration at this point.

Drive No. 2 was also calculated for four and nine-tooth sprockets but the center distance was changed toward the optimum to the condition shown in *Fig. 2c.* Here again, a secondary load transfer occurred, but since the center distance is near the optimum value the change in velocity and acceleration occurred near the start of the driver pitch cycle. In this case, the acceleration variation, due to a change in linkage components, results in a higher maximum acceleration value at the start of the motion. The velocity and acceleration curves for this drive at the optimum center distance would be almost identical with the curves shown for drive No. 2, except that the peak acceleration shown at the start of the acceleration curve would be eliminated.

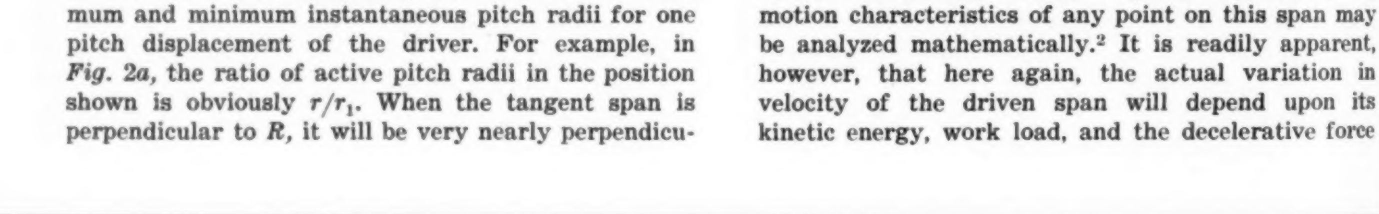
Curves in *Fig.* 3 for drives No. 3, 4, 5, and 6 were all calculated at the optimum center distance and clearly illustrate the rapidity with which the velocity variation decreases as the number of sprocket teeth increases. In each drive analysis the sprocket ratio and number of links in the tangent span were increased proportionately to maintain the same linkage ratios as closely as possible.

When a close approximation of the differences between the maximum and minimum instantaneous angular velocities of the output shaft is required, it can be obtained by comparing the ratios of the maximum and minimum instantaneous pitch radii for one pitch displacement of the driver. For example, in *Fig. 2a,* the ratio of active pitch radii in the position shown is obviously r/r_1. When the tangent span is perpendicular to R, it will be very nearly perpendicular to R_1 and then the ratio of pitch radii will be, approximately, R/R_1. The maximum percentage variation in angular velocity may be closely approximated by comparing these two ratios. Referring to *Fig. 2b,* the ratios to be compared are obviously r/R_1 and R/r_1. This latter combination will be found to have the greatest variation as shown in the calculated curves plotted in *Fig.* 3.

For example, in a drive consisting of an 8-tooth and a 16-tooth sprocket coupled by 1-inch pitch chain; $R = 1.3066$ in., $r = 1.2071$ in., $R_1 = 2.5629$ in., and $r_1 = 2.5137$ in. Then, with the center distance as shown in *Fig. 2a,* $r/r_1 = 0.4802$, and $R/R_1 = 0.5098$, which indicate velocity variation of approximately 6.2 per cent.

With the center distance as shown in *Fig. 2b,* $r/R_1 = 0.4710$, and $R/r_1 = 0.5198$, which indicate velocity variation of approximately 10.3 per cent.

It should be kept in mind that the velocities and accelerations plotted in *Fig.* 3 are only angular values for the driven shaft. As previously mentioned, a drive of one to one ratio with a center distance and tangent span equal to a whole number of pitches will transmit uniform angular motion through the driven sprocket. However, the linear velocity of the connecting span will not be uniform and will, therefore, be subjected to linear accelerations. In the case of a conveyor, where the motion of this span and its connected masses may become of some importance, the motion characteristics of any point on this span may be analyzed mathematically.[2] It is readily apparent, however, that here again, the actual variation in velocity of the driven span will depend upon its kinetic energy, work load, and the decelerative force



Curve No.	Number of teeth: Driving sprocket	Driven sprocket
1	4	9
2	4	9
3	6	14
4	8	18
5	12	27
6	21	47

Fig. 3—Effect of sprocket ratio on output shaft velocity and acceleration. Curves 1 are for the drive shown in *Fig. 2b.* Curves 2 are for *Fig. 2a.* Curves 3, 4, 5 and 6 are for optimum center distances

required to cause the span to pass through the complete calculated velocity cycle.

Besides increasing the polygonal effect, sprockets of small numbers of teeth greatly decrease the chain life and increase the velocity of impact at each pitch engagement. It is generally agreed that with all other factors equal—such as speed and lubrication—chain life is somewhat proportional to the angle of articulation of the chain links in engaging and disengaging the sprockets. On this basis, a decrease from 17 teeth to 15 teeth represents approximately 13 per cent greater chain wear, while a decrease from 23 to 21 teeth represents approximately 9 per cent increase in chain wear. Thus, it can be seen that as the number of teeth increases, the benefit from the decrease in polygonal effect and chain wear tapers off. Many engineers use 23 teeth as a working minimum with sprockets below this value used only after careful consideration of the drive conditions. Usually, where space restrictions prohibit the use of larger sprockets, multiple width chains of finer pitch can be used, allowing the use of sprockets of greater number of teeth and smaller size.

Several other factors such as lubrication, centrifugal force, chain kinetic energy, and the energy of impact as the rolls engage the sprockets are known to influence the performance and life of chain drives. The true action of a chain on and between sprockets is of a very complex nature due to the effect of each of these factors on the chain motion. However, as each facet of the problem is individually and independently investigated, a step is taken toward the eventual complete analysis of roller-chain dynamics as a whole.

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2. G. J. Talbourdet—"Characteristics of a Point on Connecting Link," MACHINE DESIGN, June, 1941, Page 81.
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Belt Tester Eliminates Guesswork

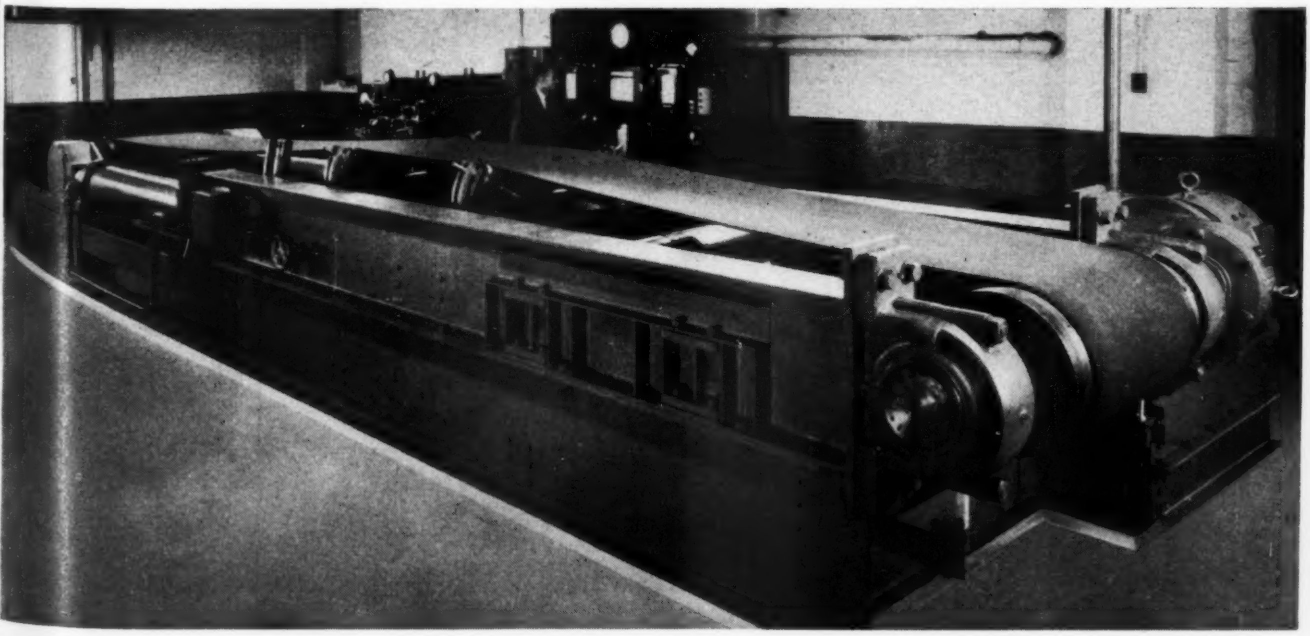
LONG-SOUGHT data on important factors in conveyor belt design and application are being obtained with a new physical testing machine recently developed by Raybestos-Manhattan engineers.

This laboratory machine, said to be the first of its kind, puts 30-inch wide by 80-feet long conveyor belts through their paces under tensile loads up to 200,000 pounds total. Actual conveyor arrangements of head, snub, bend, take-up, and tail pulleys are duplicated, including adjustable angle and elevation of troughing pulleys. Automatic recorders simultaneously trace power input, stretch, tension and speed at rates up to 2000 feet per minute.

Recordings show the effect of pulley sizes, actual strength and factors of safety of belts subjected to predetermined tensions and overloads. Elasticity and permanent stretch are measured through cycles of minimum, average and maximum belt tension. The relationships between troughability, sag between idlers, belt thickness and tension also are indicated.

Relative life expectancies of vulcanized field splices and mechanical belt joints flexing over the pulleys are being established on the machine in relationship to straight nonflexing tensile loads, thus providing a yardstick of strength and operating safety factors.

Data recorded by the new tester will supplement the already experienced judgment of conveyor designers and relieve both the manufacturer and purchaser of the sometimes costly application by trial and error method.



PRODUCTION

Modern Practices in Manufacture

AND

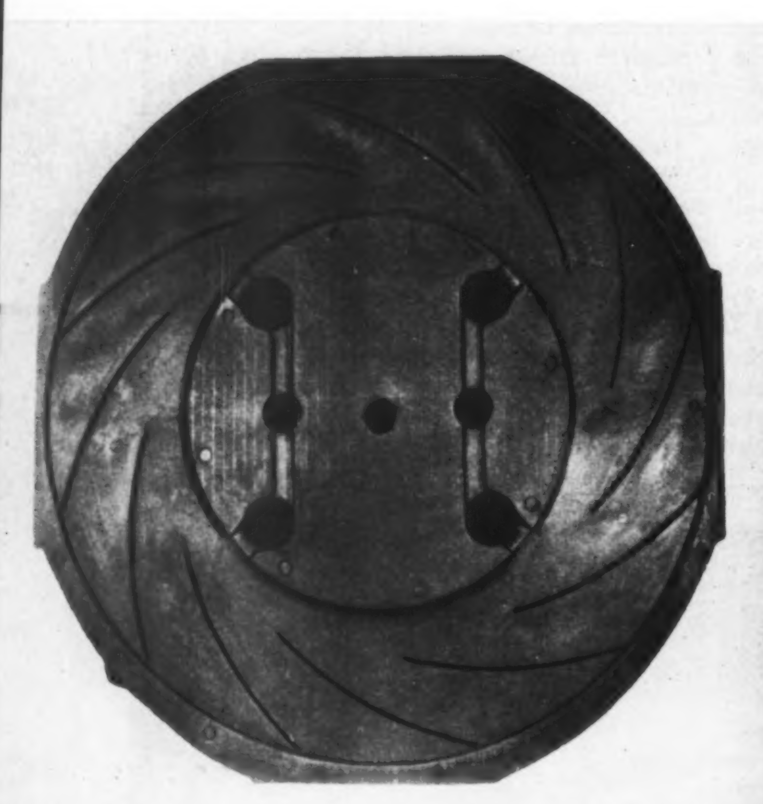
DESIGN

Shell Molding

Now used in several completely mechanized foundry operations, shell molding techniques offer new opportunities in casting design along with worthwhile cost savings

By Roger W. Bolz

Associate Editor, Machine Design



FEW foundry developments during recent years have created greater interest than the shell molding process. From the design standpoint it makes possible the use of highly precise cast parts at conventional sand casting costs. Unusual dimensional accuracy and exceptionally smooth as-cast surfaces make the process attractive when final overall costs are seriously considered, *Fig.* 1.

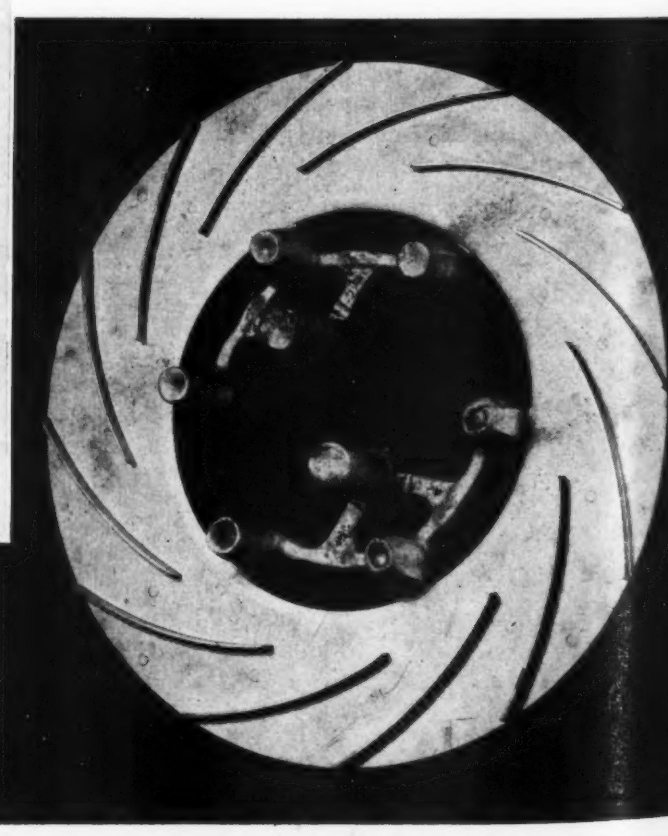


Fig. 1—Shell mold, above, for a cast aluminum turbine diffuser, right, is 32½ inches in diameter. Castings come from the mold within 0.005-inch tolerance overall and are produced in 75 per cent less time than in straight sand molding

Fig. 2—Shell mold and gate of iron castings are shown below and shell-cast part is shown at left in enlarged views. Processed in lots of 300, the shell molded connecting rod reduced machining time by almost 30 per cent over the sand cast part, far right

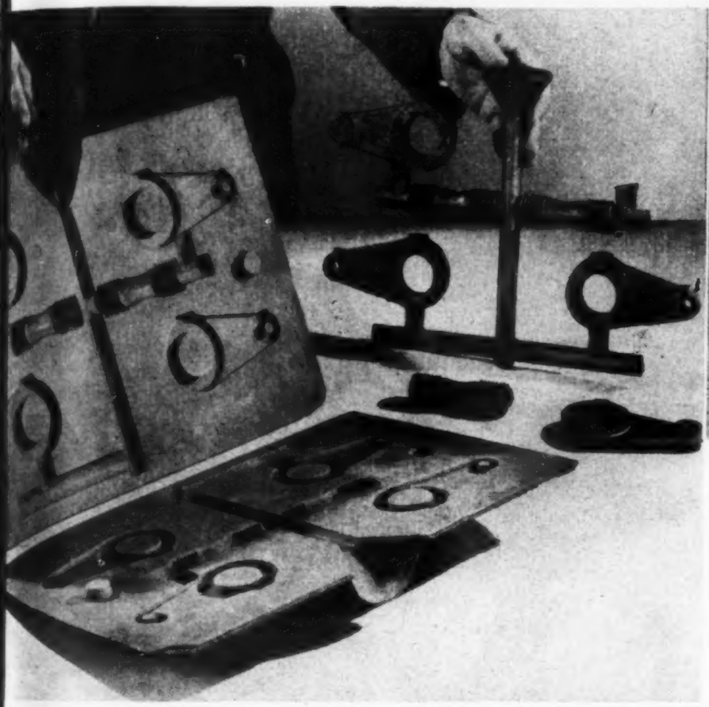
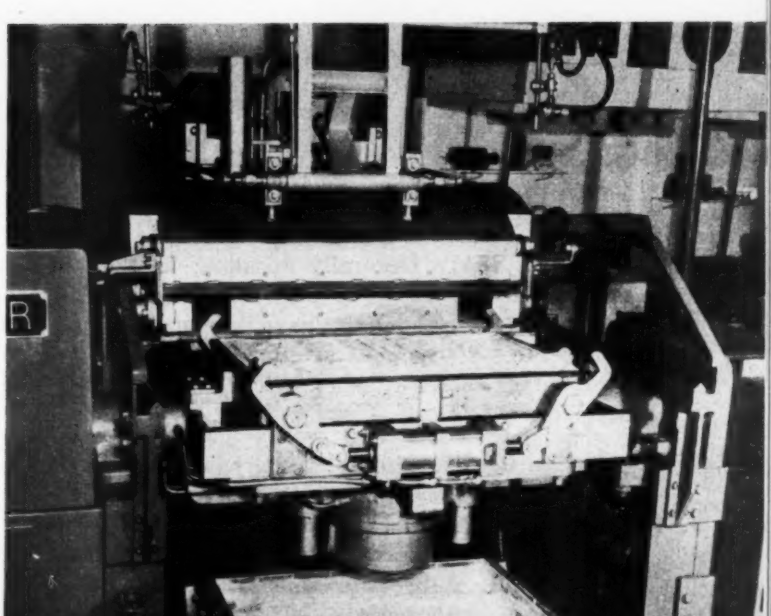


Fig. 3—Below—Completely automatic machine for producing shell molds. Two sizes of this machine accommodate patterns up to 20 by 30 inches or 26 by 41 inches. Total machine cycle time is 33 seconds plus coating time from 3 to 20 seconds and curing time of 3 to 35 seconds



Basic Process: The primary feature of the shell molding process is, of course, the resin-sand mold utilized. Steps in the process are generally:

1. Machined metal patterns for cope and drag sections of the mold are heated to 300 to 500 F
2. Phenolic resin and sand mixture is charged onto face of hot patterns. Heat of patterns causes resin to flow and surround sand grains adjacent to pattern face, forming a thin partly cured shell
3. Excess resin-sand mixture is dumped and patterns with adherent shells are placed in curing oven at 600 to 1200 F
4. Cured shells are stripped from patterns and mold halves are matched and clamped, taped, glued, or bolted together
5. Completed molds are positioned vertically in flasks and are surrounded with metal shot or sand or merely placed in vertical racks
6. Molten metal is poured and after solidification the shells are broken away.

A pair of shell molds and cast parts are shown in *Fig.* 2 along with data on savings effected. Production speed can be high and the process can readily be completely mechanized, *Fig.* 3.

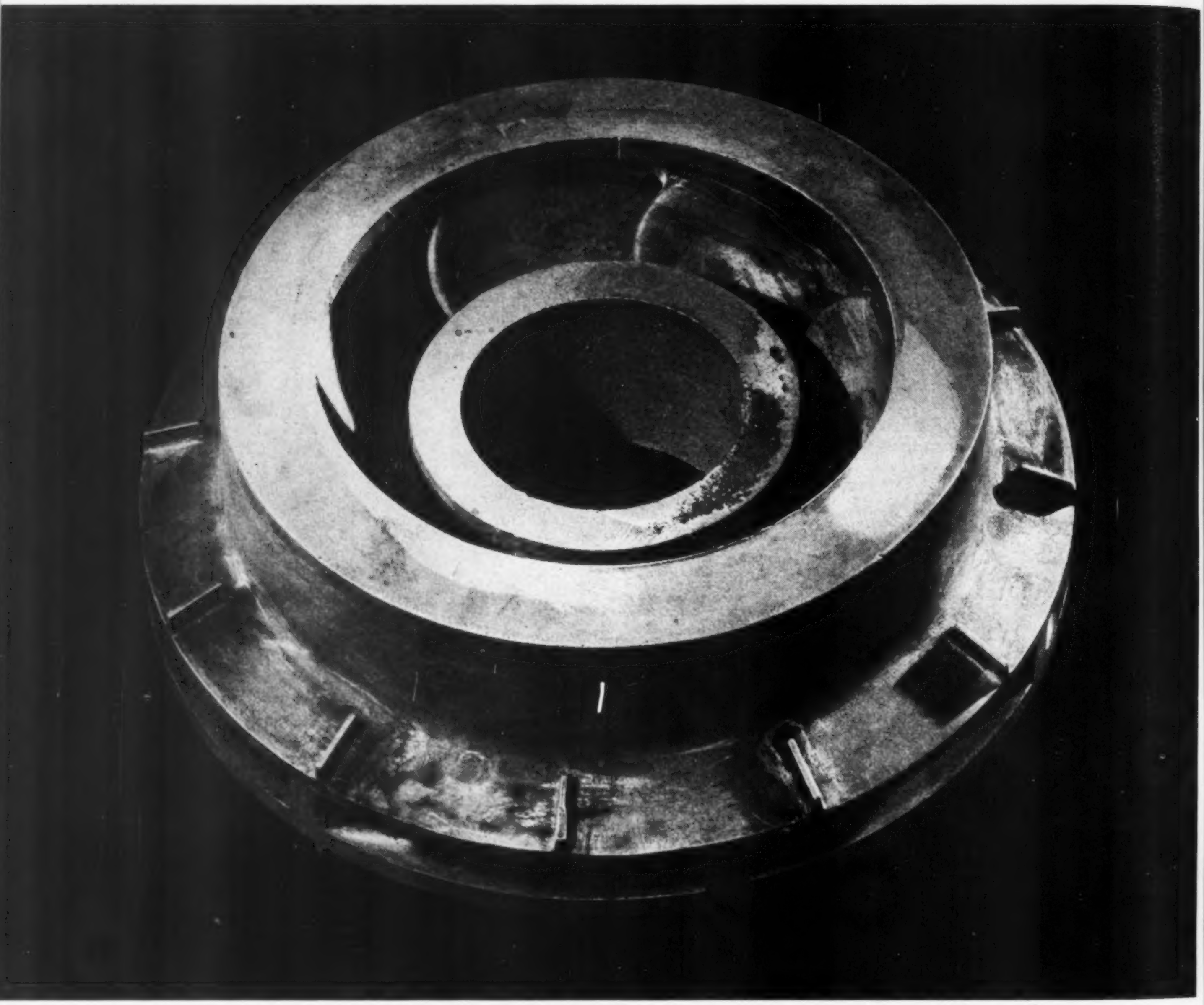


Fig. 4—Complex cored aluminum impeller casting produced with shell cores

Casting Size: Generally speaking in the way of weight, castings up to 70 pounds in cast iron and 35 to 40 pounds in aluminum have been produced. Some in excess of 200 pounds are now in process. Size is expected to increase as experience with the process develops.

Design Considerations: Long, vertical sections are difficult to produce with shell molding. However, thin sections are more readily produced than in green sand because of smoother mold surfaces and lower chilling rate. Detail, figures, ornamental design, and sharp corners are easily held.

Small holes can be cast readily. Cores similar to the molds can be used but some foundries use solid urea resin bonded cores in sizes 4 inches and smaller. Registration of shell cores in shell molds is positive and dimensionally accurate. As a result, no allowance need be made for core shift or misalignment. Complicated shell cores are possible through fusing together of separate or multiple corepieces. Such coring is used for the impeller shown in *Fig.* 4.

Tolerances: Generally, castings can be produced to tolerances of 0.002 to 0.003-inch per inch in just about any metal. Depending on design and material, however, tolerances can be held within 0.001-inch per inch and less, *Fig.* 1.

Materials: Shell molding is particularly well suited to aluminum, gray iron, ductile iron, malleable iron, low-lead low-tin bronzes, stainless and high-alloy steels. Only limited work has been done with magnesium alloys. Problems encountered with low-carbon steels are being overcome and work in this field shows promise.

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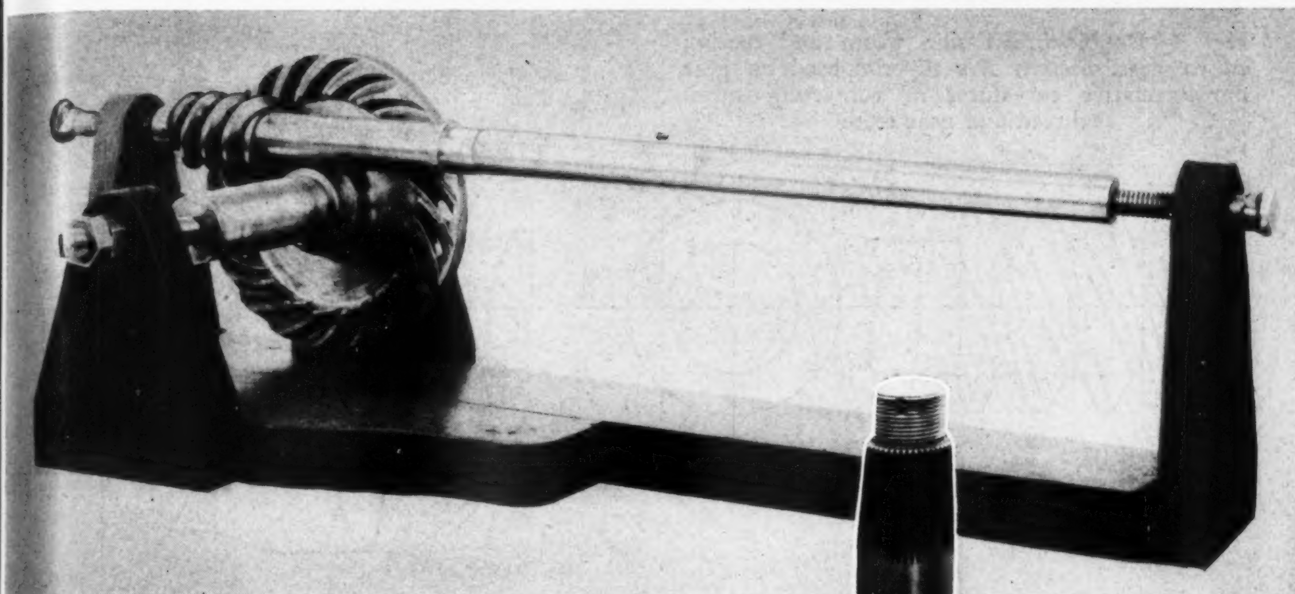
(*Figs.* 1 & 4) .... Tonawanda, New York
Sutter Products Co. (*Fig.* 3) .... Dearborn, Michigan



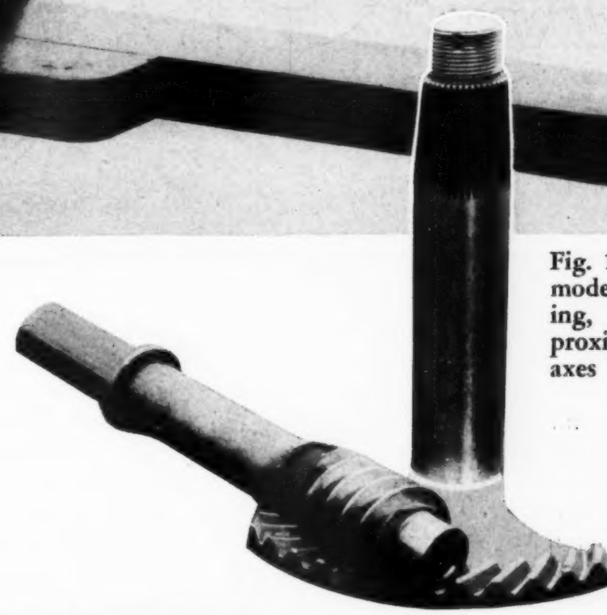


Fig. 1—Above — Working model of side-worm gearing, showing how close proximity of worm and gear axes permits compact design

Fig. 2 — Left — Side worm and crown gear quadrant currently performing heavy-duty service in truck steering mechanism

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SIDE-WORM GEARING

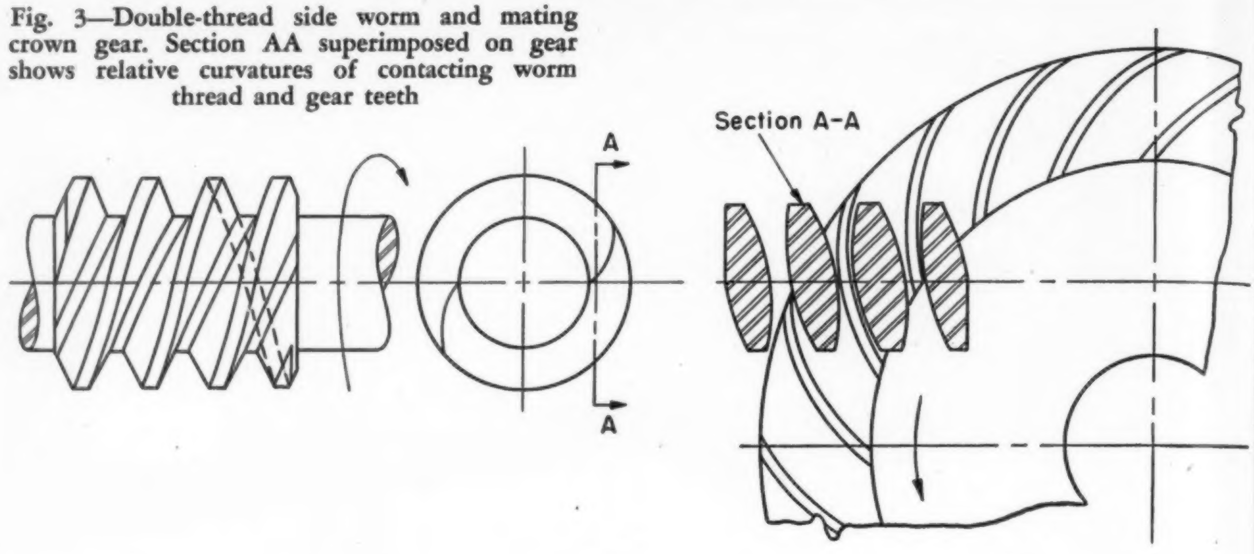
How to design and produce this unique right-angle speed reducing system

WHERE considerable speed reduction is required in a single right-angle gear unit, the side-worm gear, *Fig.* 1, offers attractive design possibilities. It is probable that most designers are unfamiliar with the characteristics of the side-worm reducer, although it has been in use for many years as a steering gear, *Fig.* 2, and it has been used advantageously in a number of small gearmotors. Based on previous experience with this unique gearing, an appraisal of its characteristics and an outline of design procedure are presented in this article.

If hypoid gearing is considered a form between bevel gearing and worm gearing, then the side worm may be considered a step between a hypoid gear and a conventional worm. So far as pitch line action is concerned, the side-worm gear is closely akin to the hypoid. However, it differs from a hypoid in that the worm, or pinion member, is of the normal helical type and therefore may be made in any worm cutting machine. The side or crown gear can be hobbed in a standard gear hobber. Another favorable feature is the easy adjustment for meshing the worm and gear properly. Axial location of the worm is not critical, although the length of the worm should be greater than the width of gear face at the point of mesh. Backlash can be taken out simply by adjustment of the crown gear alone.

It should be pointed out that the simple helical worm and hobbed gear do not give entirely true tooth action as the parts come from the machine; but if the parts are made of hardened steel, they can be lapped easily, just as spiral or hypoid gears are lapped. If the gear is bronze, it can be burnished to proper mating action with a polished worm. Errors

Fig. 3—Double-thread side worm and mating crown gear. Section AA superimposed on gear shows relative curvatures of contacting worm thread and gear teeth



in tooth action will increase with attempts to make a small diameter crown gear in relation to the diameter of the worm or hob; but within the limits later specified, successful gears have been produced.

Some of the fundamentals of a successful side-worm gear may be understood from *Fig.* 3. The worm has a left-hand thread, as also have the worms shown in *Figs.* 1 and 2. In *Fig.* 3, if the worm were rotated in the direction indicated it would produce counterclockwise rotation of the crown gear. Axial movement of the worm would also cause the gear to rotate, as a rack would a pinion or gear.

An important consideration involves that section of the worm which fits against the concave side of the spiral crown tooth. From *Fig.* 3 it is obvious that the radii of the worm sections must be smaller than the corresponding inside radii of the crown gear teeth. A study of the worm will show that the smaller the diameter of the worm, the smaller will be the contact radii of the worm sections. Also, the greater the pressure angle of the thread, the smaller will be the radii of these sections.

Since the teeth of the crown gear are spiral in form, the radius of the spiral is smallest at the inside of the face of the gear and it is at this point that the worm must be made to fit. Therefore, one of the first design steps is to establish the size of the worm consistent with strength requirements. Calculations for this part need not differ from usual design practice for worms.

Axial pressure angles of 26 and 28 degrees have been used successfully in side worms, but the higher the pressure angle, the lower the efficiency and the greater the loads on the mounting and thrust bearings.

On the basis of established worm proportions, the approximate inside diameter of the crown gear face is

$$D_I = \frac{2.1\, d_{rW}}{\tan \phi_{xW}} \qquad (1)$$

where D_I = inside diameter of crown gear face, inches; d_{rW} = root diameter of worm, inches; and ϕ_{xW} = axial pressure angle of worm thread, degrees. From experience, the factor 2.1 has been found practicable for ratios ranging between 10 to 1 and 22 to 1. It may be found through experiment that the crown gear can be made smaller than indicated by Equation 1, but in general, better tooth contact and improved action will result with larger gears.

In all calculations, except for speed ratios, the double-thread worm is treated as a single-thread worm. In *Fig.* 4 which shows this combination, construction lines 1 and 2 on the crown gear indicate directionally and dimensionally the circular pitch of the gear and the normal pitch of the worm, respectively. Also designated is the angular relationship of these lines at the point of intersection of the worm axis and the inside circumference of the gear face. In further calculations the outside diameter of the worm and inside diameter of the gear face will be used, for if satisfactory mesh is established at their intersection the worm and gear will mesh at other regions with negligible error.

Referring to *Fig.* 4, the relationship of the thread lead angle to lead at outside diameter of the form is

$$\tan \lambda_o = \frac{l_W}{\pi\, d_o} \qquad (2)$$

where λ_o = thread lead angle, degrees; l_W = worm thread lead, inches; and d_o = outside diameter of worm, inches.

The corresponding normal pitch of the worm thread is

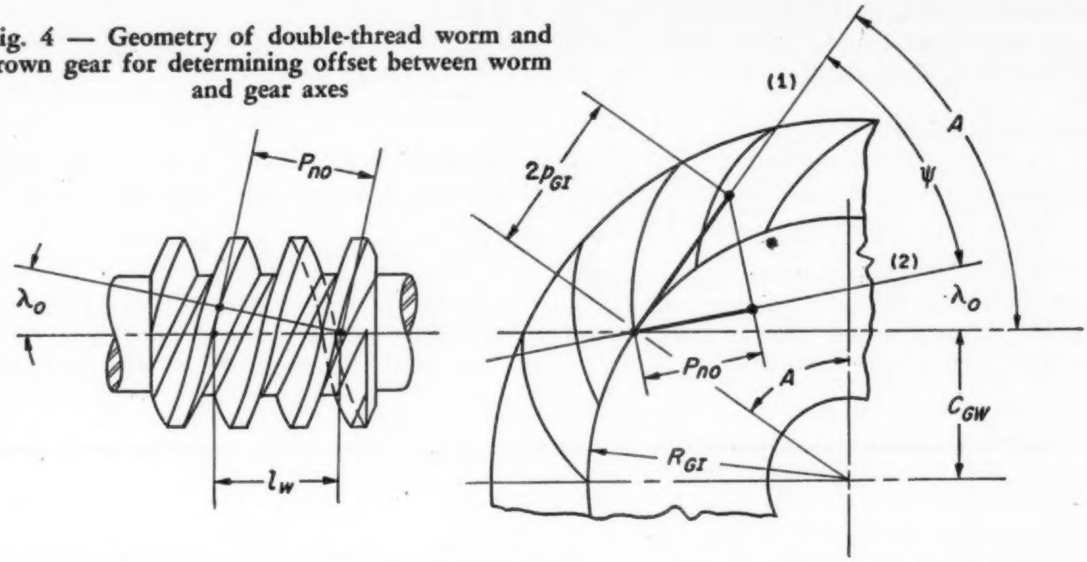
$$p_{no} = l_W \cos \lambda_o \qquad (3)$$

where p_{no} = normal pitch of thread at outside diameter of worm, inches.

Circular pitch of the crown gear is

$$p_{GI} = \frac{\pi\, D_I}{N} \qquad (4)$$

Fig. 4 — Geometry of double-thread worm and crown gear for determining offset between worm and gear axes



where p_{GI} = circular pitch of gear teeth at inside diameter of gear face, inches; and N = number of teeth on crown gear.

Angular relationship of lines 1 and 2 in *Fig.* 4 is

$$\cos \psi = \frac{p_{no}}{p_{GI}} \quad \text{(5)}$$

where ψ is expressed in degrees. The offset or center distance between axes of worm and crown gear in inches is

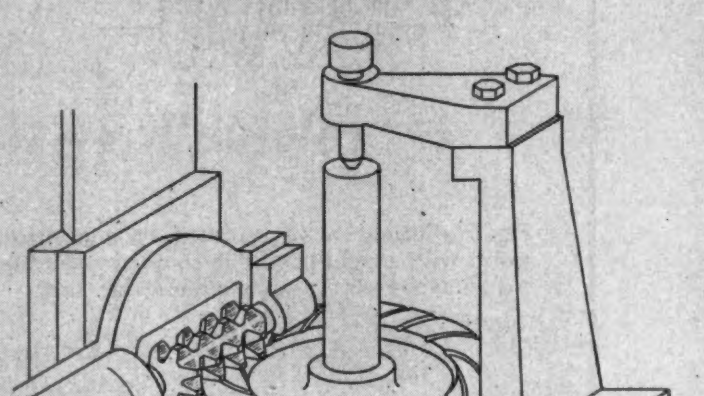
$$C_{GW} = R_{GI} \cos (\psi + \lambda_o) \quad \text{(6)}$$

In hobbing the crown gear teeth, as illustrated by *Fig.* 5, the hob lead direction should be opposite to that of the worm lead. This provision permits up-cut hobbing which is desirable since it avoids risk of the hob pulling the work into the cut. It will be understood, from *Fig.* 6, how a right-hand hob and a left-hand worm, or vice versa, will mesh with the same crown gear at different center distances simply because of the gear tooth curvature.

If the inside diameter of the gear permits, the hob diameter may be greater than that of the worm within the proportions previously outlined for worm and gear diameters, although the hob diameter could be less than that of the worm. Because a single-lead hob cuts smoother gear teeth than does a double-lead hob, it is desirable to specify single-lead hob data for crown gears to be used with double lead worms. Accordingly, the normal pitch of the single-lead hob should be one-half that of the double-lead worm. In a hobbing setup of this nature compensation must be made, of course, for lead angle difference between hob and worm so that the gear tooth spiral ultimately will match the worm threads at proper center distance. It can readily be visualized that the farther a hob is located from the crown gear axis, the greater will be the spiral angle of the gear teeth.

To illustrate the calculations, *Fig.* 7 shows a 20-

Fig. 5—Below—Schematic arrangement of hobbing setup for cutting teeth of crown gear with right-hand hob for left-hand worm



tooth gear to be used with a double-lead worm in a 10 to 1 ratio gear as in *Fig.* 4. Construction lines 1 and 2 in *Fig.* 7 indicate directionally and dimensionally the circular pitch of the gear and the normal pitch of the hob, respectively. Also designated is the angular relationship of these lines at the point of intersection of the hob axis and inside circumference of the gear face.

Application of Equations 1 to 6 establish the following side-worm gear design data based on a *double* thread worm having a lead of 0.75-inch, and an outside diameter of 1.187 inches; D_I = 3.23 inches, λ_o = 11 deg 22 min, p_{no} = 0.735-inch, P_{GI} = 0.5105-inch,

$\psi = 43$ deg 58 min, and $C_{GW} = 0.923$-inch.

Since the normal pitch of the double-lead worm is 0.735-inch, a single-lead hob to cut a mating gear must have a normal pitch equal to half of this, or 0.3675-inch.

Lead angle of the hob is

$$\sin \lambda_h = \frac{p_{noh}}{\pi\, d_{oh}} \qquad (7)$$

where λ_h = hob lead angle, degrees; p_{noh} = normal pitch of hob at outside diameter, inches; and d_{oh} = outside diameter of hob, inches. For an assumed hob diameter of 1.187 inches, $\lambda_h = 5$ deg 38 min.

Angular relationship between lines 1 and 2 in *Fig. 7* is

$$\psi_{Gh} = \frac{p_{noh}}{p_{GI}} \qquad (8)$$

where ψ_h is expressed in degrees. The offset or center distance between axis of hob and gear is

$$C_{Gh} = R_{GI} \cos A_h \qquad (9)$$

where C_{GH} = offset between hob and gear axis, inches; and R_{GI} = inside radius of crown gear face, inches.

By solution of Equations 7 to 9, the offset between

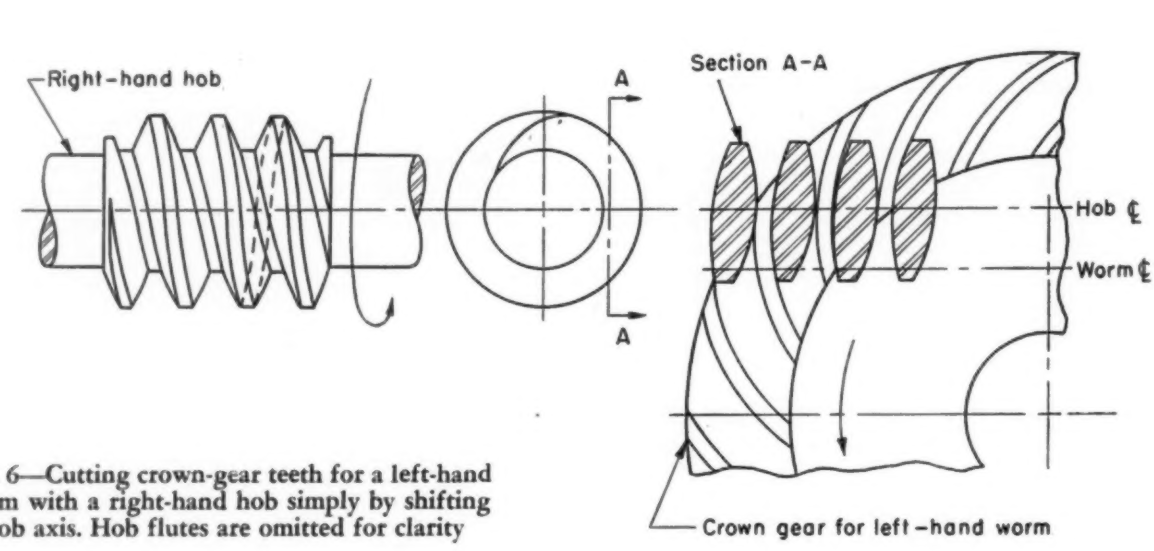


Fig. 6—Cutting crown-gear teeth for a left-hand worm with a right-hand hob simply by shifting hob axis. Hob flutes are omitted for clarity

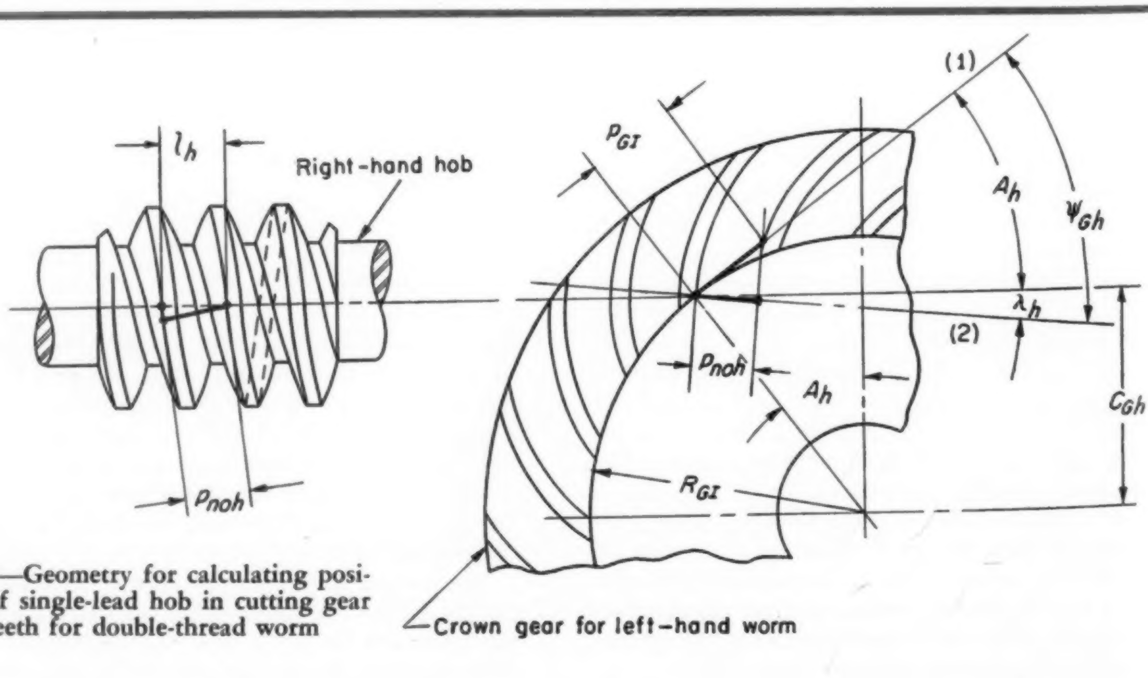


Fig. 7—Geometry for calculating position of single-lead hob in cutting gear teeth for double-thread worm

hob and crown gear axes in the example outlined is 1.275 inches, whereas the offset between operating axes of the worm and crown gear is 0.923-inch. To assure optimum tooth contact in a gear of this type, the worm should be available for trial in the gear during hobbing. Also, a trial run may indicate that slight deviation from the calculated center distance may improve tooth contact.

In gears of this type made of steel and hardened for operation under heavy loads, the coefficient of friction is known to be approximately 0.07. Where a bronze gear and steel worm are used, a lower coefficient will apply within reasonable speed and load limits. Adequate lubrication should be provided on the order of that normally used in hypoid gearing.

For side-worm gearing the unit efficiency exclusive of losses incurred in bearings is

$$E = \frac{\cos \phi_{xW} + \mu \tan \psi_m}{\cos \phi_{xW} + \mu \cot \lambda_p} \qquad (10)$$

where E = efficiency, per cent; μ = coefficient of friction; ψ_m = spiral angle at mean radius of gear face, degrees; and λ_p = lead angle of worm at pitch diameter of worm, degrees.

For the gear example described, the following data can be taken: Pitch diameter of worm = 1.000 inch, pressure angle of worm = 28 deg, and mean radius of gear face = 2.000 inches. Lead angle at the pitch diameter of the worm is

$$\tan \lambda_p = \frac{l_W}{\pi d_p} \qquad (11)$$

where d_p = pitch diameter of worm, inches.

Spiral angle of the gear teeth at the mean radius of the gear face is

$$\cos \psi_m = \frac{k p_{np}}{p_{Gm}} \qquad (12)$$

where k = thread multiple of worm; p_{np} = normal pitch of the worm thread at the worm pitch diameter, inches; and p_{Gm} = circular pitch of the gear teeth at the mean radius of the gear face, inches.

From Equations 10 to 12, and with a coefficient of friction of 0.07, efficiency of the example unit previously developed is 83 per cent, exclusive of frictional losses in the shaft bearings.

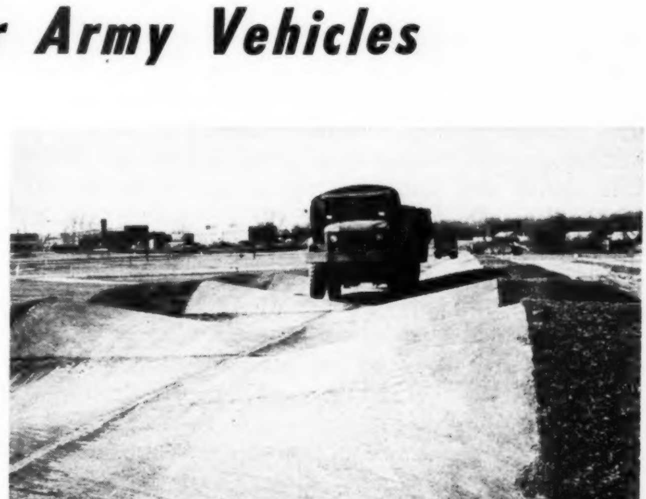
With the worm shaft mounted in antifriction bearings and the gear shaft in plain bearings, a bearing loss of approximately 10 per cent has been estimated in gear units of this type. This value was arrived at from tests conducted with slow-moving heavily loaded gears ranging in ratios from 18 to 21.

Rough Testing for Army Vehicles

ARMY vehicles are tested for performance under difficult conditions of road surface and terrain at the Aberdeen Proving Ground, Maryland. Special washboard, gravel, sloping and Belgian types of roads have been constructed, as well as rivers and areas for testing under simulated combat conditions. Tanks, which sometimes weigh as much as 100 tons, have a special course of rivers, roads and woods.

One obstacle course, the "frame twister," is designed to subject vehicle frames to severe punishment. One of the latest vehicles developed by Army Ordnance, the XM34 "Eager Beaver" truck, is shown as it travels this course.

In another test a waterproofed jeep is required to go through a water bath. In the middle of the bath, the Jeep is stopped when its engine is completely covered with water, the ignition is turned off, and the engine must then be restarted.



"They [standards] have made it possible to conduct this fabulous productive machine with the least amount of spare parts and inventories in the hands of the consumer industries. They have sharpened competition. They have cheapened the cost of production in millions of directions. Thus they have enabled thousands of different articles to be placed within the reach of everybody. They do not impose uniformity on the individual because they make available to him an infinite variety of additions to his living."—HERBERT HOOVER

Fig. 15—A primary link in obtaining permanent control is to train shop supervision in the specific steps required to start and to continue running control charts

Part 3–How and Where to Control

MOST quality control engineers wonder why their programs of as long as even a few years' standing are still only moderately successful. The limited degree of active pushing by inspection and production management personnel seems to keep this useful tool from its logical and rapid growth. Work becomes discouraging, because each specific case tried results in real success either in eliminating scrap and rework or in revealing valuable information that would otherwise go unnoticed. SQC appears so obviously good that other people aware of the results should clearly be expected to extend its use enthusiastically. But they do not. The bridge is missing.

One or two pushers of an idea do not virtually unaided sell it to a going shop. About the best that can be done with shop supervisors, whose primary interest is to get out production, is to stir up an inkling of the possibilities. They see the benefits of applying SQC methods only to the specific cases tried. The needed link is to train shop supervision in the specific steps to start and to continue running under control, *Fig.* 15. Such links should be connected by agreements with top shop supervision that for at least six months they will continue to push their people for a gradual but steady increase in the number of charts used. Finally, as a result the shop will establish through their own efforts knowledge of the capabilities of the processes—when to leave them alone and when to adjust them. Quality control engineers then can follow up in the training by surveying the work. They simply clear up the spots where difficulties and questions are met.

It is the self-perpetuating feature of this scheme that makes it work. When almost everyone in a shop has had personal success, the techniques are in to stay, and the designers can work with the added freedom mentioned.

Where Is Control Needed?: *Fig.* 6 of Part I gave an orderly method for deciding which specifications in the shop should be charted by using scrap records priced by the accounting department. Trouble with rather few specifications made up as much as three-fourths of the total avoidable cost. It was these few shop operations that needed the first control charts. The scheme generally fits well into job shop operations.

If, by chance, such data are not handy, fraction defective or p charts can be used. This is the production shop approach. Each of these general charts will guard the quality of all specifications for a given part. Charts with too high an *average* fraction defective, called $\bar{p}$, will stand out. The charts will also show by the points crossing control limits whether a significant improvement or an adverse effect is present. Just chance variations are those that remain within the control limits of the chart.

Assume there are twenty-four operations required to make a certain product and that final inspection results are as plotted on the chart of *Fig.* 16. The inspection could consist of a single check, or a check on perhaps two or three characteristics of the finished product. On the other hand, if the product is a machined piece, the final check might consist of twenty-four separate inspections where each operation formed another dimension.

First the average fraction defective is determined.

QUALITY CONTROL METHODS

Their Use in Design

By Dorian Shainin
Chief Inspector
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The steps are: (1) Pick a sample size, say 50 items of product; (2) record how many items of product in each sample were found to contain one or more defects; (3) divide the total number of defective items (not individual defects) by 50 to give a $\overline{p}$ or fraction-defective value for each sample. Plot a minimum of ten such sample results in their order of production on the chart. The average fraction defective, p is the total number of defective items found in *all* the samples divided by the total of the number of items checked.

If the sample size from point to point is fixed, the ten or more separate fraction-defective ratios can simply be averaged to get $\overline{p}$. The distinction made however, is that the former plan describes the more general case and applies whenever the sample size might vary. If fraction-defective records are kept on a basis of daily production, the number inspected each

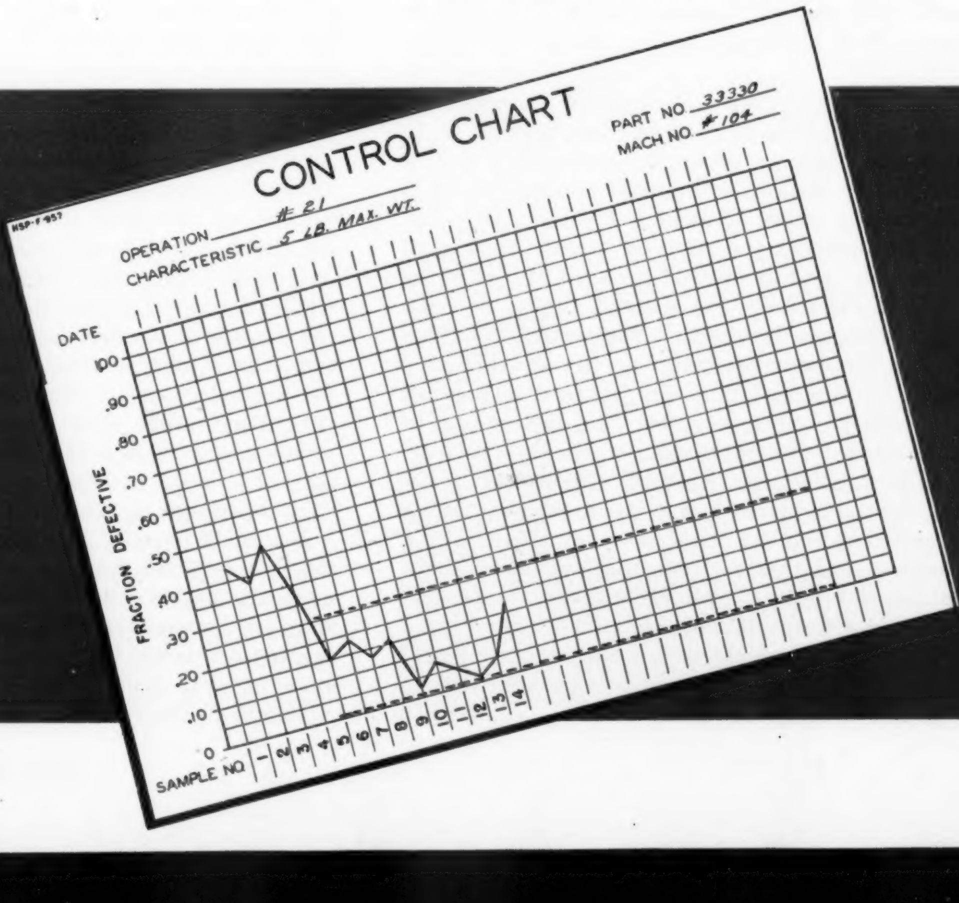


Fig. 16 — Plotting results on this fraction defective chart from successive samples of 50 parts each resulted in immediate improvement. Control limits were computed from the last ten "stabilized" points

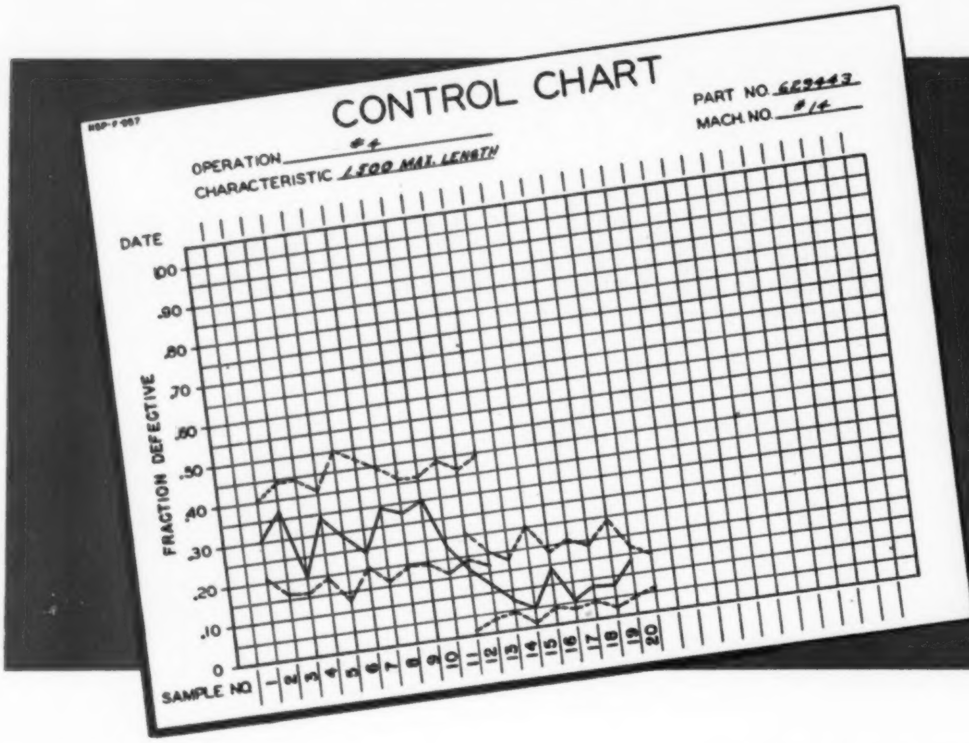


Fig. 17—A typical $\overline{p}$ chart for daily production. Sample size varied so control limits had to be changed

day would not likely be the same. Arithmetically you are not entitled to average fractions with different denominators. In *Fig.* 17 is shown a $\overline{p}$ chart in which the number of pieces inspected for each point varies.

Graph for the Band of Chance Variation: The control limits for each point of a $\overline{p}$ chart, or for the entire chart when the sample size is fixed, are readily determined from *Fig.* 18. The average fraction defective for the last ten or more points is always used where there is visual evidence indicating variation around a fixed average value. Whenever a point crosses one of the control limits during production, action must be taken. When points on the chart clearly appear to vary around a different average, a new $\overline{p}$ line with its proper upper and lower limits should be drawn. This should be done just as soon as ten successive points about the new average line are obtained.

In *Fig.* 18, from the average fraction defective the lower and upper limits that correspond to the sample size are found. This graph shows control limits that are not equally distant from the average line on a scale marked in units of sample fraction defective.

Herein lies another contribution of *Fig.* 18 beyond that of readily giving control limits. Contemporary texts almost universally recommend that a formula be used to compute the control limit positions. This formula results in control limits equally spaced above and below the average line. The texts freely admit that this is not entirely correct. The distribution of chance fraction-defective values, of random samples picked from a lot that is a certain fixed fraction defective, is not symmetrical. But the approximation is argued as being fair on the basis that the resulting error is small, and that the true value of the lot fraction defective is never exactly obtained unless we use an infinite number of samples.

The chart saves working with a formula and places the control limits at the proper theoretical positions. If the average fraction defective determined from the series of samples does happen to be equal to the true fraction defective of the lot, at these positions there will then be an equal and small chance that random points will occur. This chance amounts to 1.3 in a thousand. Such probability limits agree with similar chances at the standard control limits of $\overline{X}$ and R charts. So the graph recognizes that the distribution is skewed or nonsymmetrical and that this skewness changes with different $\overline{p}$ values. It also includes a proper correction for the small sample sizes used for some of the curves, and which is needed for the region of low values.

Action Signalled by the General Chart: A point out of control means the inspection records should be checked for that point as compared to the others to see what brought about this significant change. The chart has indicated it was not chance. Was it trouble with a certain specification out of the twenty-four that are combined on the chart?

If the point fell above the upper control limit the first thing to check is whether there has been a tightening of inspection standards. Has a new, more rigid method of checking been introduced? Was a worn gage replaced by a new one? If all is in order on the inspection front, then look to the production operation itself. The corrective action may be quite clear and can be taken at once. On the other hand an average and range control chart at that operation may be the needed "tool" to find the basic difficulty. In the rare cases where even this chart does not solve the problem, the action to take will be that described further along in this series under the heading, "Trouble Shooting Machine Designs."

Never, if possible, set a new $\overline{p}$ value higher than the previous one that was being kept. An excepton is when the higher value comes from a tightening of inspection standards and a study has shown that this increased severity is justified. Perhaps it should have been that way from the start.

Points below the lower control limit of a $\overline{p}$ chart

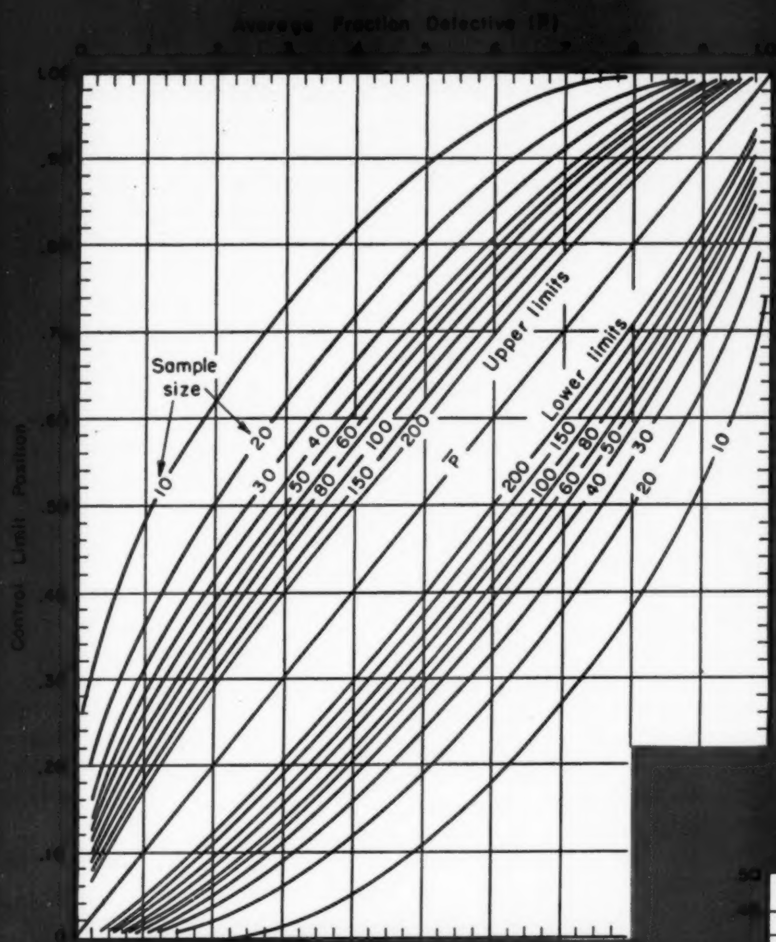
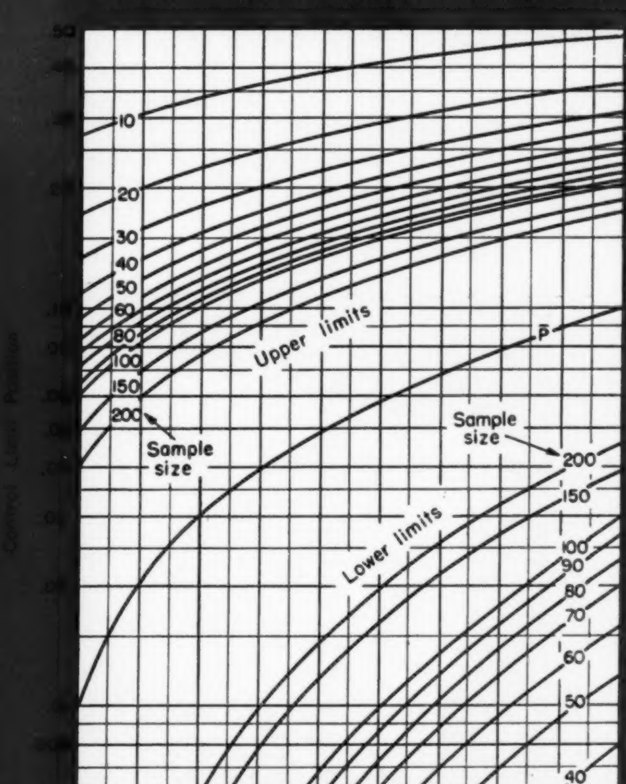


Fig. 18—Control limit position is given in units of sample fraction defective on these charts for determining the 99.74 per cent probability band of chance variation for a $\bar{p}$ chart



should also be first looked at for a possible lowering of standards. If a check reveals that this is not the case then it is well to place a lower $\bar{p}$ value around which to aim, just as soon as there are enough points. Some of these investigations leading to the reasons for improvement provide a method for maintaining or even bettering the lower per cent defective level.

Specific Steps for the Detail Chart: Here is how an $\bar{X}$ and R chart is made. First enter on a work sheet* the readings found for successive pieces that make up a single sample. Most plants use 5 as a handy sample size, some use 4 and a few use 3 results. Next add these values and write the sum for each sample. Divide the sum by the sample size and enter the average value. Finally, note the highest and the lowest readings of the sample, subtract one from the other and mark the difference under a column of the work sheet headed "Range." Plot the values for the average and range for each sample on the control chart.

Control limits for averages and for the ranges come from two multiplications for which a pair of

* "Predicting Machine Capability"—Dorian Shainin, MACHINE DESIGN, January 1950.

constants is used.* Each constant multiplied by the average of ten or more of the ranges gives the positions of each of these limits. The limit line for averages is placed at this figured distance both above and below the line standing for the actual average of the ten or more sample averages. The limit for ranges is set at the figured distance above a zero-range level, this level representing a lower "control limit."

A much simpler yet equally effective control chart is called a sum and range chart. Instead of using averages of successive samples the sums are plotted. After all, the sums will vary just as the averages do, the only difference being that the sums will be proportionately larger. They will be n times larger where n stands for the sample size. Also always keep the sample size down to three pieces each. This change eliminates the need for a separate work sheet. Measurements may be entered directly on the chart itself.

Fig. 19 shows such a sum and range chart and brings out the detail steps for making one. In this example an outside diameter is ground to a basic or nominal size of 6.4994-inches with a close tolerance. An air gage is used to measure the product. Each division on the gage is 0.000050-inch and each unit on the left-hand vertical scale on the sum and range chart also stands for a "half tenth." The zero setting on the air gage corresponds to 6.49925-inches, which is at the low tolerance limit allowed for the work.

The three pieces for sample No. 1 each measured three units on the air gage. As soon as the first piece was made and measured the number 3 was marked on the upper or sum section of the chart against the left-hand scale value of 3. The second reading was entered by another 3 at the intersection of the same vertical sample number line with a horizontal line that is three units higher. This point is at 6 on the left-hand scale. The third reading gave a total or accumulated value of nine, and this last entry of three units was circled. It is the sum point for the first sample. Finally, a glance at the three numbers marked one above another showed there was no difference among them and a dot was placed at the level zero on the range section of the chart for this sample.

The second sample readings of 2, 3, and 4, gave the same total of 9 but a range value of 2, the difference between 2 and 4, the extreme readings of the sample. This procedure was continued until thirty pieces had been completed and measured, giving ten sample ranges and ten circled sum points.

The upper and lower control limits for sums and the upper control limits for ranges come from products similar to the $\overline{X}$ and R case. The actual average range and average sum from the first ten samples are used, following the original setup, along with the pair of constants. The first ten range values add up to 15 units. This means the average range is 1.5 units. For a sample size of three items the upper control limit for the range section of the chart is 2.57 times the average range. In this case the product is 3.85 or about 3.9 units. For the sum section of the chart, an average of the first ten sums must be made. The total is 90, so the average for the sums is 9.0. Again, for a sample size of three, the upper and lower control limits for sums lie at a distance of 3.06 times the average range above and below this central average line of 9.0. Multiplication gives 4.59 or places the control limits at 9.0 ± 4.6; or 4.4 and at 13.6.

If these control limits show one or more sum or range points to be outside, the limits are not valid. The process was not operating in statistical control even while the basic data were being taken. Only one sample being out justifies leaving both the sum and range values for that sample out of the calculations. Refigure for the nine samples or take an eleventh set of readings. But if more than one sample

*See previous reference, Page 171.

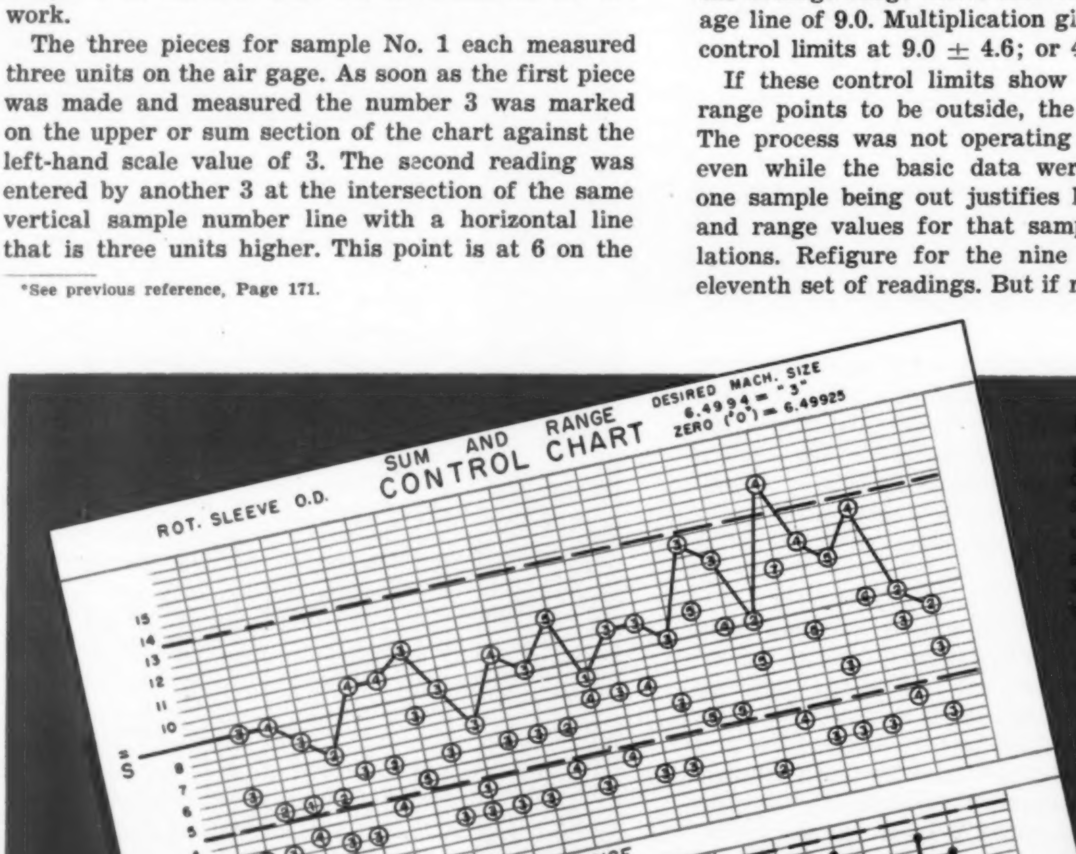


Fig. 19—A simple but effective control chart showing individual readings and also comparing sums and ranges with control limits

contains sum or range points out of control, the process needs steadying down. The assignable cause of the nonrandom variation must be removed or the test must wait until only the variables characteristic of the process are again working alone.

Variables in any process are numerous. They cause the results to jump around. The operator has a real friend in the sum and range chart in that it gives him boundary lines for the inevitable, built-in variation. Results that come within these control limits in the future will actually serve to advise the operator not to try to adjust his process. This fact almost means that the operator can increase his production rate and will do so unconsciously.

Most machine operators try to recognize coming trouble as the sizes appear to go too close to either specification limit. The sum and range chart replaces this actually questionable judgment of the good, experienced operator with a reliable tool. With this indicator he can now make a definite decision when to act and when to leave things alone.

Another result, of a psychological nature, is of particular interest to the designer. The operator watches the points fall on the control chart as a rifleman would the pattern of tracer bullets. Just as he would see when to correct the aim of his rifle, the operator finds he can aim his machine to give results that fall within the band. Improvement in the total variation, which represents the smallest natural tolerance under the circumstances, in many cases becomes more than theoretically valuable.

Controlling Automatic Equipment: Logical reasoning says that for most automatic or semiautomatic operations the variability of the process remains quite constant. The absence of the disturbing elements so characteristic of manually controlled operations makes it so. Thus a check that the machine settings are at the same place for later repeat runs becomes imporant. A statistical tool for determining that the setup is ready to run is called a Reset-Run card.

One of nine preprinted stiff paper forms is selected. Each resembles those shown in *Fig.* 20 except that the numbers in the left-hand vertical scale and those printed in the upper and lower triangular regions marked RESET will differ among the cards. The numbers have been selected to fit the inherent standard deviation of any process. The particular card that has a value closest to the standard deviation encountered is employed.

The basic card represents a standard deviation close to unity. Note from *Fig.* 21 that the numbers in the left-hand scale, one for each line, stand for intervals of one unit. The other eight cards have intervals of 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0, and 8.0. For a standard deviation close to ten units the basic card would be used which we can call 1.0. Any value can thus be handled with one of these cards by selecting a convenient decimal point location.

The cards come in such size that any point can be reached with a ticket punch having a 2-inch throat depth. The scheme of punching holes instead of requiring marks with a pencil particularly appeals to screw machine operators whose product comes out in a bath of oil. Pencils are not handy in oily fingers.

As an example of the selection of a Reset-Run card,

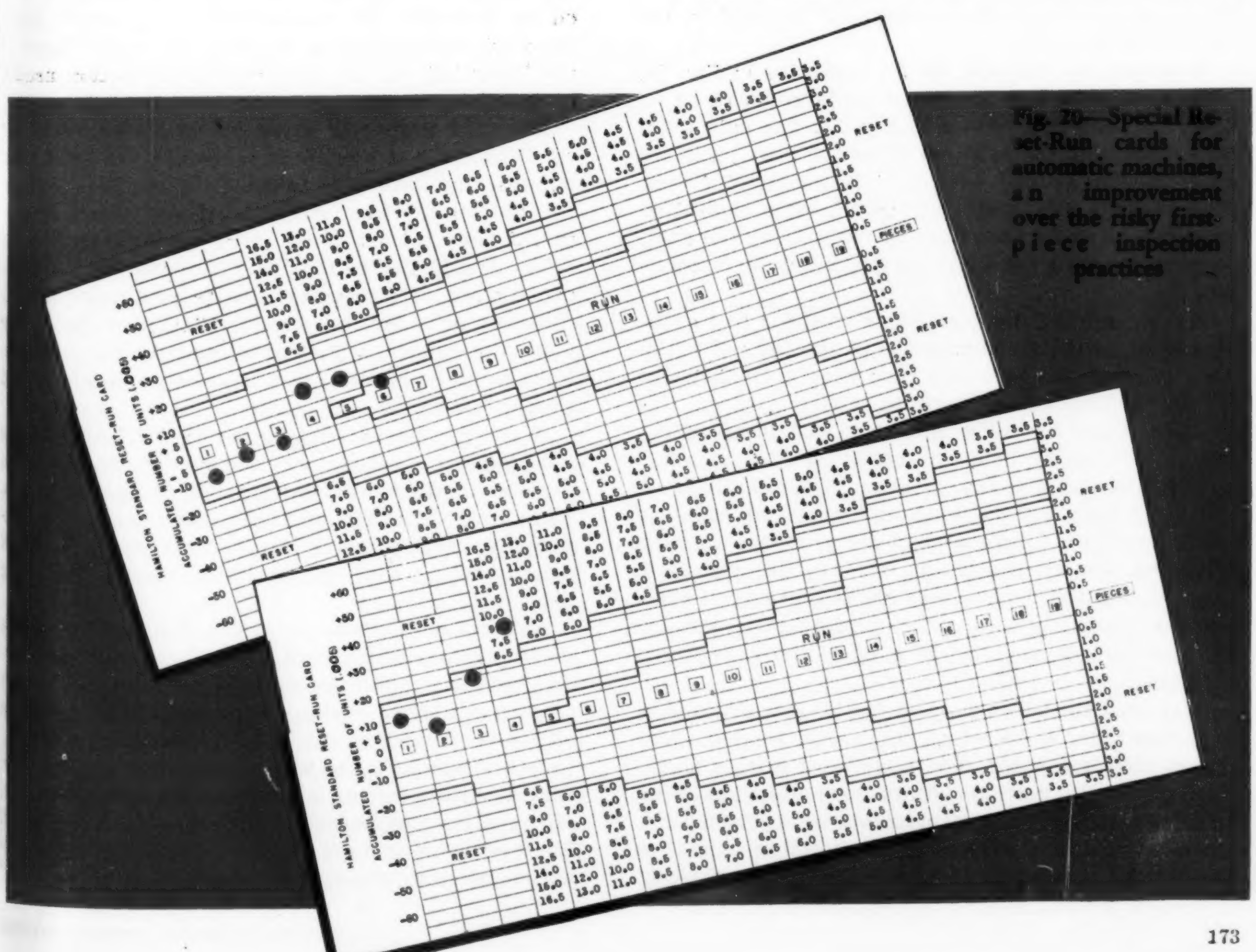


Fig. 20—Special Reset-Run cards for automatic machines, an improvement over the risky first-piece inspection practices

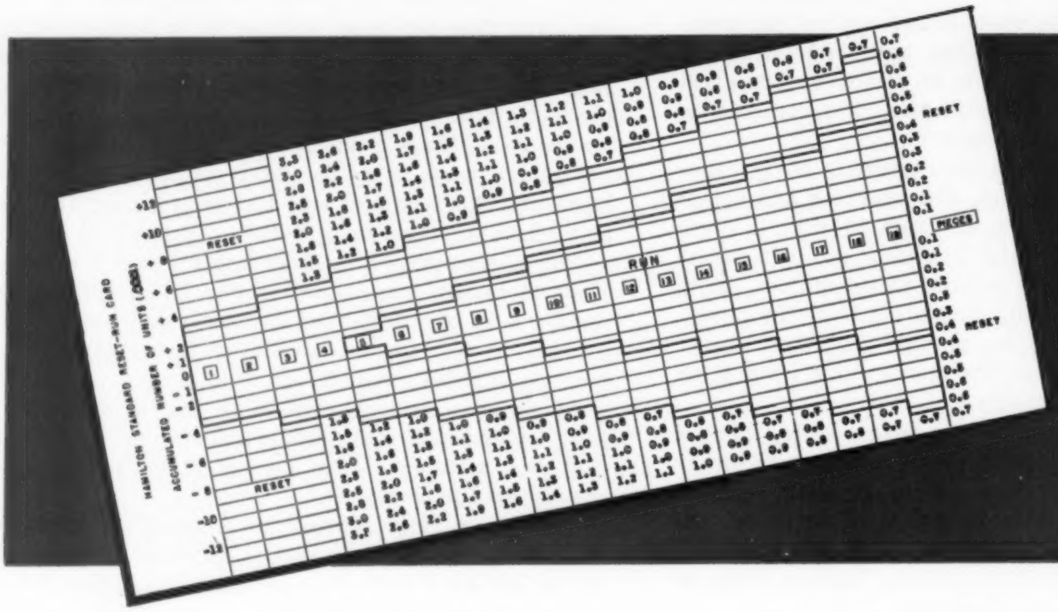


Fig. 21—Basic Reset-Run cards for unity deviation. Numbers given are used to figure those for the other cards of the complete set

the card for five units would be used if the standard deviation of the process is found, say from a previous control chart, to be anywhere between 0.00450 and 0.00549-inch. The standard deviation from the control chart is one-sixth of the natural tolerance for individual pieces. To find its value, multiply by 0.59 the average range of ten or more successive samples of three items each. The Reset-Run card units are so selected that the difference between any actual standard deviation and that of the card will result in a maximum error of from ten to twenty-five per cent. Such an amount will not defeat the purpose of the card.

Note that on the card for five units, as in *Fig.* 20, each number is just five times as large as those on the card for unity, shown in *Fig.* 21. The only numbers remaining the same on all of the nine cards are those in the central horizontal line marked *Pieces.* They always run from one to 19. Any Reset-Run card can be easily computed by multiplying the numbers on the card for unity by the desired card interval.

Having selected the Reset-Run card for five units, it will be necessary to measure to the nearest 0.005-inch interval. An indicator type gage is needed that allows distinguishing between differences of this amount. Gage accuracy is tied to the standard deviation. Obtaining indicator gages for the cards 1.0, 2.0, 2.5, and 5.0 is no problem. The markings on standard dials can be read easily as: so many of these intervals to correspond to so many lines on the card. For the cards 1.5, 3.0, 4.0, 6.0, and 8.0 a blank dial should be properly marked or special graduations, having values other than the conventional divisions, can be supplied by most of the gage manufacturers.

The first Reset-Run card of *Fig.* 20 shows a process that was found to be set correctly after six successive pieces were measured. The other card of this figure comes from a machine found to require resetting after four successive measurements were punched out.

Each successive measurement shows as a hole so many lines above or below zero for the first piece; so many lines above or below the previous hole for the second piece, and similarly for succeeding pieces to give an accumulative reading. When a hole crosses the boundary line into the region marked RUN or that marked RESET, the measuring stops. A hole in the RUN region means the process setting lies sufficiently near the desired value so that it is not necessary to take any more readings. A hole in the RESET region punches out a printed number. This number represents a good estimate of the amount the machine is actually set away from the value for zero on the indicator. The numbers above the center stand for work with indicator readings too high. Those in the lower half of the card show a correction needed in the other direction.

The card purposely gives no usable estimate for resetting until at least four successive readings from one machine have been taken. So if the first reading was not too far from zero, the process should be continued for at least three more pieces even though holes already fall in the RESET region. But a reading far out of line would justify resetting the machine at once by the amount that piece fell away from the desired value, as a very rough estimate. Each time the machine is reset a new Reset-Run card should be started.

Punch marks that end up in the RUN area of the card indicate a satisfactory setting and the operation can be allowed to proceed without further attention. At certain intervals of time, determined from experience, other Reset-Run cards should be punched out to confirm that the process setting is still being held.

As mentioned, these cards are designed for a risk of 10 per cent of giving a RESET reading for a perfect setting on the value selected for zero; 10 per cent of giving a RUN reading when the actual setting is either one standard deviation too high or too low. In other words, there will be 90 per cent certainty that a perfect setting will be approved and that one, off by at least one standard deviation, will be rejected. These risk levels have proved to be a practical balance between precision and economy.

Water Hammer in Hydraulic Systems

... how to determine pressure-surge effects resulting from rapid valve closure

By Harold K. Palmer
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—*Photo, Courtesy Parker Appliance Co.*

Fig. 1 — Checking pressure surges on cathode-ray oscilloscope. Surges in the hydraulic system under investigation are caused by rapid valve closure

IN ANY hydraulic system if a sudden force is applied at one end of a fluid column, tending to change its velocity, a pressure wave will travel through the column with the velocity of sound in that fluid. On reaching the far end the wave will be reflected back. It will behave in every way like a sound wave of condensation and rarefaction. If the system has one or more dead-end branches, the wave will travel through and be reflected by each branch. Should two or more reflected waves meet in the same phase the result will be a pressure equal to their sum. Often these waves produce noisy and damaging vibrations, commonly referred to as water hammer.

Although water hammer is usually associated with the sudden stopping of the fluid column, it can originate also in static columns subjected to sudden acceleration. For example, a cork can be started from a bottle by turning the neck down and striking the bottom. In this case the pressure wave acts to force the cork out. Similarly on striking a liquor barrel near the bung with a bung starter, the bung will be forced out by the pressure of the reflected wave.

Any fluid column in motion has kinetic energy due to its mass and velocity. To stop it, work must be performed on the fluid by applying a force which can be found from the work equation (see Nomenclature); that is,

$$F = \frac{v^2 W}{2gx} \qquad (1)$$

In case of a sudden stoppage, if the liquid were incompressible and the pipe inelastic, x would be zero and F would be infinite. However, all liquids are compressible and all pipe materials are elastic so that x has a small finite value. Experiments have demonstrated that if the column is stopped by closing a valve in less than the critical time, which is the time for the pressure wave to travel to the end of the column and back, the effect is the same as instantaneous closing. While this may be a matter of seconds or minutes in long pipes, it is a matter of milliseconds in short control systems, *Fig.* 1.

The following is a formula for maximum pressure rise resulting from water hammer which contains the constants usually used in control systems:

$$P = \frac{v}{12}\sqrt{\frac{wKEt}{g(tE + D_oK)}} \qquad (2)$$

The effect of pipe expansion being much smaller than that of the compressibility of the fluid a much simpler approximate formula can be used, assuming no elasticity in the pipe:

$$P = \frac{v}{12}\sqrt{\frac{wK}{g}} \qquad (3)$$

This equation gives values of P which are a few per cent high but which err on the side of safety.

Table 1—Effect of Tube Size on Wave Velocity

Tube Ratio D_i/t	Velocity of Wave Propagation Copper (fps)	Aluminum (fps)
10	4460	4300
7	4560	4430
4	4660	4570

The value of P for water is $63v$ and for oil, with specific gravity of 0.8 and K of 250,000, it is $53v$.

Velocity of Wave Propagation: The velocity of wave propagation in a given fluid depends upon the velocity of sound in that fluid and, to a less extent, on the elasticity of the pipe. A good formula for this is given by R. W. Angus (*Transactions American Society of Civil Engineers*, Vol. 104, 1939, Page 345) modified to suit small pipe:

$$v_w = \frac{12\sqrt{\frac{gK}{w}}}{\sqrt{1 + \frac{KD_i}{Et}}} \qquad (4)$$

For oil having $w = 50$ lb/cu ft and $K = 250{,}000$ psi, using copper tubing with $E = 15{,}600{,}000$ psi, Equation 4 reduces to

$$v_w = \frac{4810}{\sqrt{1 + 0.016\frac{D_i}{t}}} \qquad (5a)$$

Using aluminum tubing with $E = 10{,}000{,}000$ psi, Equation 4 becomes

$$v_w = \frac{4810}{\sqrt{1 + 0.025\frac{D_i}{t}}} \qquad (5b)$$

The effect of various values of D_i/t for both copper and aluminum tubing is shown in TABLE 1. For most practical purposes, a mean value of 4500 fps would be sufficiently accurate.

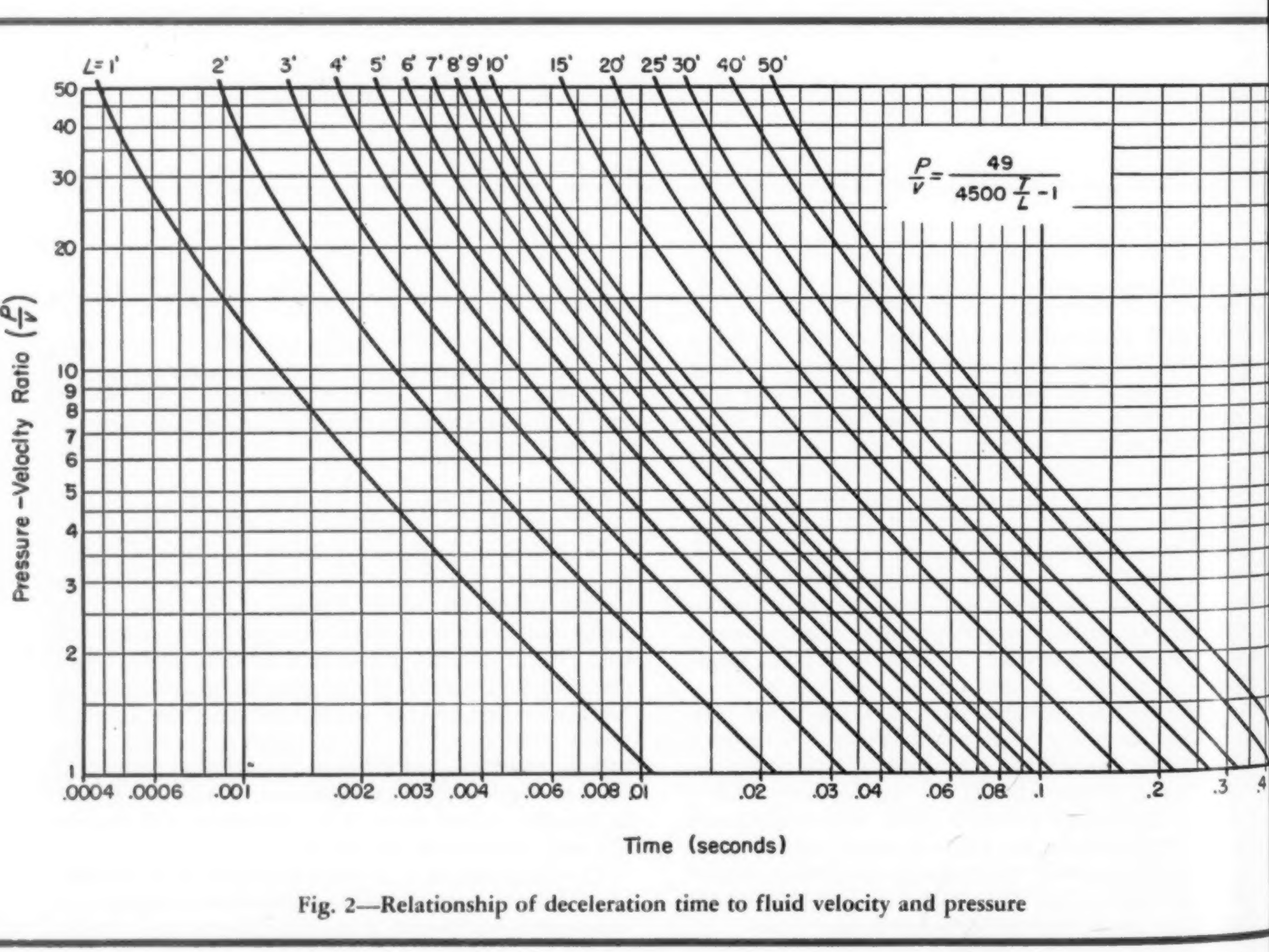


Fig. 2—Relationship of deceleration time to fluid velocity and pressure

Critical Time: The critical time for valve closure is the time for the pressure wave to travel from the valve to the end of the pipe and back, or

$$T_c = \frac{2L}{v_w} \qquad (6)$$

In control systems, L is usually only a few feet at most, making the value of T_c a matter of thousandths of a second. Using the mean value of 4500 fps for v_w,

$$T_c = \frac{2L}{4500} = \frac{L}{2250} \qquad (7)$$

The critical time can be increased by the following methods:

1. Lengthening the pipe, which results in an increase in fluid friction
2. Using more elastic pipe material. This makes only a very small increase in critical time for any metallic pipe. A rubber hose which stretches visibly would give much more time
3. Attaching an accumulator to the pipe close to the valve. This would give much more time by absorbing the inertia flow of oil in the increased storage space. A cylinder with a plunger opposed by a spring would give the same effect

Slow Valve Closure: A formula by Warren (Urquhart--*Civil Engineering Handbook,* McGraw-Hill, 1940, Page 352) gives the following value for the increase in pressure in terms of feet of fluid.

$$h = \frac{Lv}{g\left(T - \dfrac{L}{v_w}\right)}$$

This formula can be put in the form

$$\frac{h}{v} = \frac{v_w}{g} \frac{1}{v_w \dfrac{T}{L} - 1} \qquad (8)$$

For oil of 0.8 specific gravity, $v_w = 4500$ fps. Therefore, Equation 8 becomes

$$\frac{h}{v} = \frac{140}{4500 \dfrac{T}{L} - 1} \qquad (9a)$$

and, converting head to pressure, since $h = 2.88P$,

$$\frac{P}{v} = \frac{49}{4500 \dfrac{T}{L} - 1} \qquad (9b)$$

EXAMPLE: If $L = 10$ ft, the critical time for closing the valve is $20/4500 = 0.00444$-sec. The pressure for closing in critical time or less is $53v$ psi, and, for closing in 0.1-sec,

$$P = \frac{49\,v}{4500\left(\dfrac{0.1}{10}\right) - 1} = \frac{49\,v}{44} = 1.11v \text{ psi}$$

The chart in *Fig.* 2 shows deceleration time for various lengths of pipes with respect to P/v relationships. This chart is based upon Equation 9*b*. As an example of the use of this chart: Determine the excess pressure of fluid caused by valve closing in 0.005-sec at the end of a 5-ft length of pipe when the velocity of oil is 10 fps. Referring to the chart, the curve for $L = 5$ shows a value of 13.5 for P/v when T is 0.005. Since $v = 10$, the pressure build up due to the valve closing is 135 psi.

Actually, Equations 9*a* and *b* are empirical; they were derived from experiments on water supply and hydraulic power systems in which water is the fluid. The original formula for water has been adapted for oil by substituting the specific gravity of oil to correct for its effect on kinetic energy. The smaller value of k has been used to correct the critical time of valve closing and the velocity of wave propagation in TABLE 1. However, the greater compressibility of oil permits it to travel a longer distance in coming to rest and thus decreases the pressure of closing. Since the original equation makes no provision for change in fluid compressibility, the diagram gives pressures which are probably too high and thus errs on the side of safety.

Nomenclature

D_i = Inside diameter of pipe, in.
D_o = Outside diameter of pipe, in.
E = Modulus of elasticity of pipe, psi
F = Force, lb
g = Acceleration of gravity, ft/sec/sec
h = Head, due to fluid stoppage, ft
K = Modulus of compressibility of fluid, psi
L = Length of pipe, ft
m = Mass, W/g
P = Pressure, surge due to fluid stoppage, psi
t = Thickness of pipe wall, in.
T = Time, deceleration, sec
T_c = Critical deceleration time, sec
v = Velocity of fluid, fps
v_w = Velocity of wave propagation, fps
w = Density of fluid, lb/cu ft
W = Weight of fluid column, lb
x = Distance fluid moves in stopping, ft
λ = Poisson's ratio

Effect of Excess Pressure: The effect of increased pressure is to cause the pipe to expand laterally, and because of Poisson's ratio, to shorten its length. If the pipe is straight between two well-anchored fittings there would be a tendency to pull it loose. If there is a bend in the pipe the pressure on the bend will tend to lengthen the pipe, but the shortening will exceed the lengthening effect. If the angle is not anchored the pipe can bend and relieve the stress.

The formula for the strain can be developed as follows: in the straight section of the pipe, increase in diameter is

$$\Delta D_i = \frac{PD_i}{2tE}$$

and expansion of the circumference becomes

$$\pi \Delta D_i = \frac{\pi P D_i}{2tE}$$

and change in pipe length is

$$\Delta L' = \frac{-PL\lambda\pi D_i}{2tE} \quad \ldots\ldots (10)$$

If there is a bend in the pipe, the tensile load because of the bend is $PD_i^2\pi/4$ and is applied to the ring of the cross section of the pipe $\pi D_i t$. Then

$$\Delta L'' = \frac{PLD_i}{4tE} \quad \ldots\ldots (11)$$

Adding Equations 10 and 11,

$$\Delta L = \Delta L'' + \Delta L' = \frac{PLD_i}{4tE} - \frac{PL\lambda D_i \pi}{2tE}$$

$$= \frac{PD_i L(1 - 2\lambda\pi)}{4tE} \quad \ldots\ldots (12)$$

EXAMPLE: Given a 1000 psi pressure increase due to water hammer in a ¼-inch copper tube, 100 inches long to a bend, to find the amount of motion when the tube thickness is 0.04-inch, Poisson's ratio is 0.33 and E is 16,000,000 psi. Then

$$\Delta L = \frac{1000 \times 0.25 \times 100}{4 \times 0.04 \times 16{,}000{,}000} (1 - 2 \times .33\,\pi) = -\,0.0108$$

If there were no bend in the pipe, by virtue of Poisson's ratio the pipe would shorten 0.0203-inch.

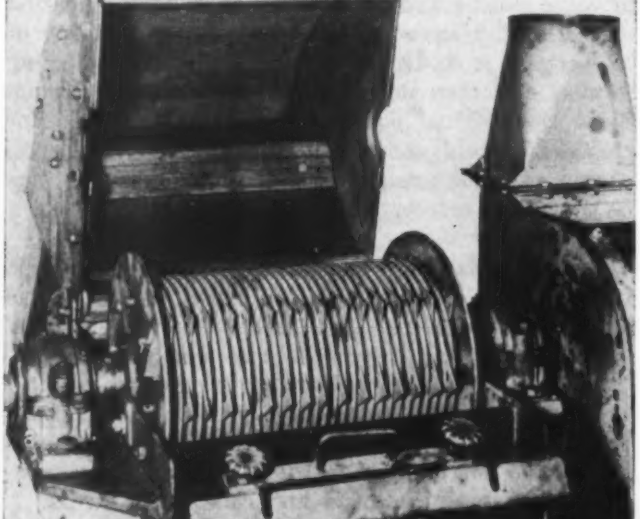
Conclusion: In hydraulic controls where circuits are comparatively short and pipes are small, the least costly methods of protection from water-hammer damage are to increase the pipe size and thereby lower the fluid velocity, or to increase the pipe wall thickness. The critical time of valve closure is, approximately, $L/2250$ sec. Therefore, a control valve designed so that it cannot close in less than 5 times the critical time will decrease the pressure surge to about ⅛ of that due to instantaneous closing.

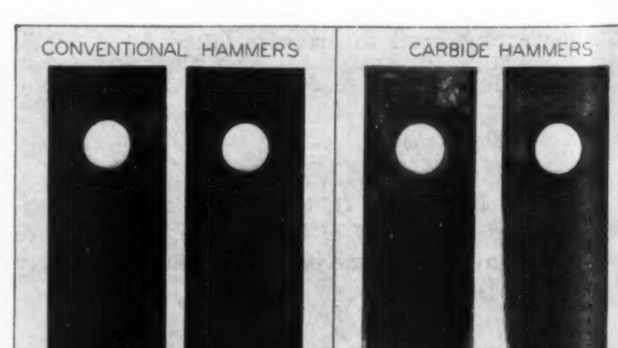
Carbide Tips Extend Hammer Life

LONGER service life, less maintenance, and reduced down time result from a comparatively simple redesign employing tungsten-carbide wear strips on thin hammer blades used in the Heil grain hammermill, below.

The conventional hardened steel blades, below right, were designed to make available four wearing surfaces throughout their service life. Because of the severe operating condition encountered, normal practice was to reverse the hammers and rebalance the rotor after 24 to 48 hours of service to restore the mill's original efficiency. This almost daily procedure entailed regular maintenance cost and much lost production time.

Manifold savings have been effected through the application, by brazing, of Carboloy strips to one working edge of the redesigned hammers. In contrast with the four to eight days total life of their predecessors, about eight weeks of uninterrupted service are possible with the new blades. In addition, the number of blades in each rotor can be reduced to one-half the original without reduction of milling efficiency. Thus, when the blades are due for replacement, less down time is incurred and routine daily servicing is eliminated.





Calculating Pressure Loss

. . . in round pipes with nomogram

By Alvin Rood
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DETERMINING pressure drop in the components of a fluid-flow system is an essential step in the design of many types of equipment. Information helpful for such calculations is contained in the literature, but often repetitive calculations can be made less tedious by the use of special graphical devices. This article presents several charts useful in speeding calculations of pressure or head losses for fluid flow in smooth round pipes.

The classical formula defining pressure loss in pipes is (see nomenclature)

$$\frac{H}{L} = \frac{f\,v^2}{2g\,\dfrac{D}{12}} \qquad (1)$$

This form can be easily rewritten to utilize the practical units common in design. Velocity can be transformed to flow:

$$v = \frac{\dfrac{Q}{7.48}}{\dfrac{\pi}{4}\left(\dfrac{D}{12}\right)^2 60} = 0.407\,\frac{Q}{D^2} \qquad (2)$$

where the numerical values are conversion constants required to reconcile the different units. Substitution of Equation 2 in Equation 1 gives

$$\frac{H}{L} = 0.0311\,\frac{fQ^2}{D^5} \qquad (3)$$

Pressure rather than head can be found from the basic relationship

$$\Delta p = \frac{H\,\rho}{144\,g} = \frac{H\,\gamma}{144} \qquad (4)$$

Or, from Equations 3 and 4,

$$\frac{\Delta p}{L} = \frac{\gamma}{144}\,\frac{H}{L} = 0.000216\,\frac{\gamma\,f\,Q^2}{D^5} \qquad (5)$$

The one property needed for evaluation of Equations 3 and 5 is the friction factor f. For both laminar and turbulent flow, the friction factor is related to Reynolds' number which is defined as

$$R = \frac{\rho\,v\,\dfrac{D}{12}}{\mu} = \frac{v\,\dfrac{D}{12}}{\dfrac{\mu}{\rho}} = \frac{Q}{29.3\,D\,\nu} \qquad (6)$$

When the Reynolds' number is less than 2000, the flow is laminar or viscous and the friction factor in a smooth pipe is

$$f = \frac{64}{R} \qquad (7)$$

Above 4000, flow is turbulent. Numerous empirical relationships have been advanced to define f in this range. The most preferred expression, suitable for a broad range of Reynolds' number, is the Von Karman-Nikuradse-Prandtl equation:

$$\frac{1}{\sqrt{f}} = -\,0.8 + 2\log R\sqrt{f} \qquad (8)$$

This transcendental function cannot be solved directly for f; however, a plot can be made of R versus f. In effect, this method of solution has been employed and applied in the nomographic method here outlined.

For Reynolds' numbers between 2000 and 4000 the type of flow is indeterminate. It may be either viscous or turbulent, the point of change is not exact,

Nomenclature

- D = Inside diameter of pipe, inches
- f = Friction factor
- g = Gravitational constant, ft per sec ^{2}
- H = Head, ft
- L = Length of pipe, ft
- Δp = Pressure drop, psi
- Q = Flow, gpm
- R = Reynolds' number
- v = Velocity of fluid, fps
- γ = Density of fluid, lb per cu ft
- μ = Absolute viscosity of fluid, slugs per ft sec
- ν = Kinematic viscosity of fluid, ft^2 per sec
- ρ = Absolute density of fluid, slugs per cu ft

Pipe Flow

Data Sheet

and the change may not occur at the same point on successive runs.

The process of calculating the pressure drop consists of three steps:

The kinematic viscosity ν of the fluid is first ascertained. *Fig.* 1 gives ν for several common fluids at different temperatures. Similar data are usually readily available for other fluids.

Next, the friction factor f is determined from *Fig.* 2, which represents solutions of Equations 6, 7 and 8.

Finally, the pressure loss is found from *Fig.* 3, which is a graphical solution of Equations 3 and 5.

EXAMPLE: Find the pressure drop per foot of 2-inch diameter pipe for AN-VV-0-366b oil at 20 F flowing at 40 gpm. Assume that the density γ of the oil is 55 lb per cu ft.

From *Fig.* 1, the kinematic viscosity ν of the oil is 0.001 ft^2 per sec at 20 F.

Next, in *Fig.* 2, project a line through $Q = 40$ gpm and $D = 2$ inches to the unlabeled scale. From this point draw a line through $\nu = 0.001$ on the left-hand ν scale. Read $f = 0.095$ on the intersected f scale. If Reynolds' number is desired also, from the same turning scale point, project a line through $\nu = 0.001$ on the right-hand ν scale. Read $R = 680$ on the Reynolds' number scale.

Finally, in *Fig.* 3, project a line from $Q = 40$ through $D = 2$ to axis AA'. Determine a point on BB' by projection through point O and the point on AA'. From the point on BB', project through $f = 0.095$ to the H/L scale. Read $H/L = 0.15$ ft per ft. To find Δp, move horizontally from $H/L = 0.15$ to the interpolated vertical for $\gamma = 55$ lb per cu ft, and diagonally upward to the $\Delta p/L$ scale. Read $\Delta p/L = 0.06$ psi per ft.

On *Fig.* 2 it will be noted that the indeterminate range of Reynolds' number corresponds to the overlap in f scales for laminar and turbulent flow.

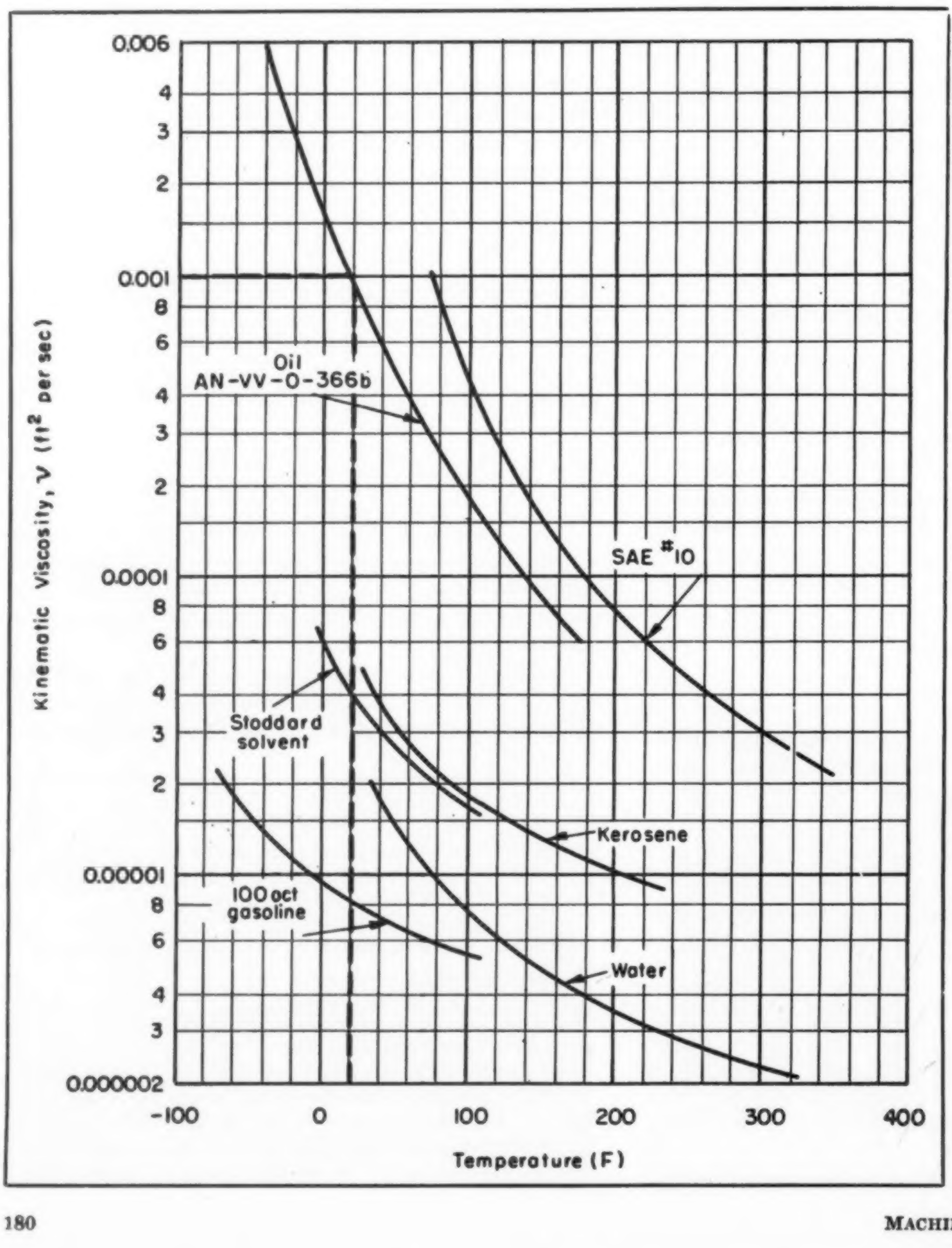
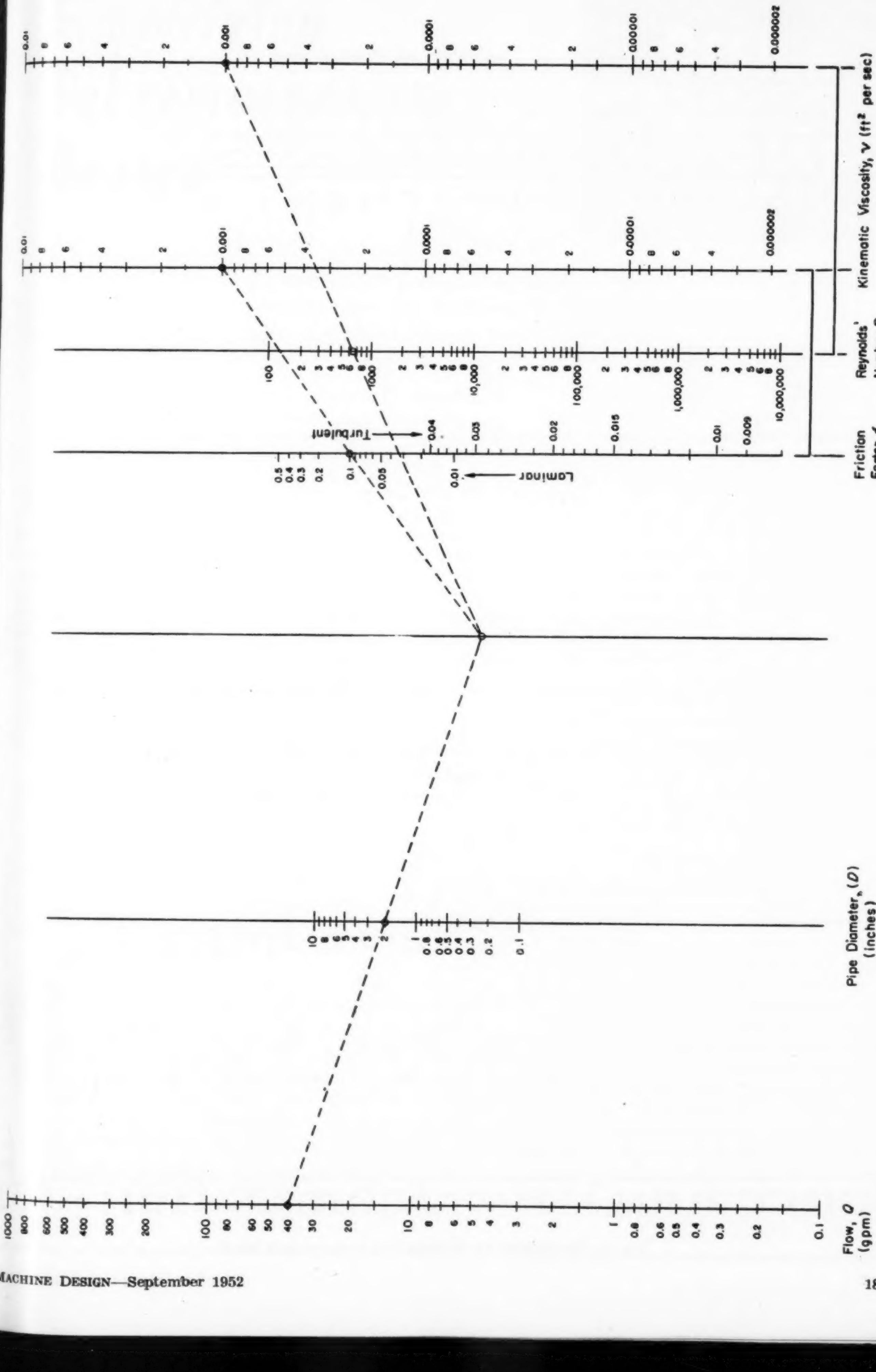


Fig. 1—Kinematic viscosity of various fluids in relation to temperature

Fig. 2—Right—Nomogram for finding friction factor for both laminar and turbulent flow. Reynolds' number can also be determined with this chart

Pipe Flow


Kinematic Viscosity, ν (ft² per sec)
Reynolds' Number, R
Friction Factor, f
Turbulent
Laminar
Pipe Diameter, (D) (inches)
Flow, Q (gpm)

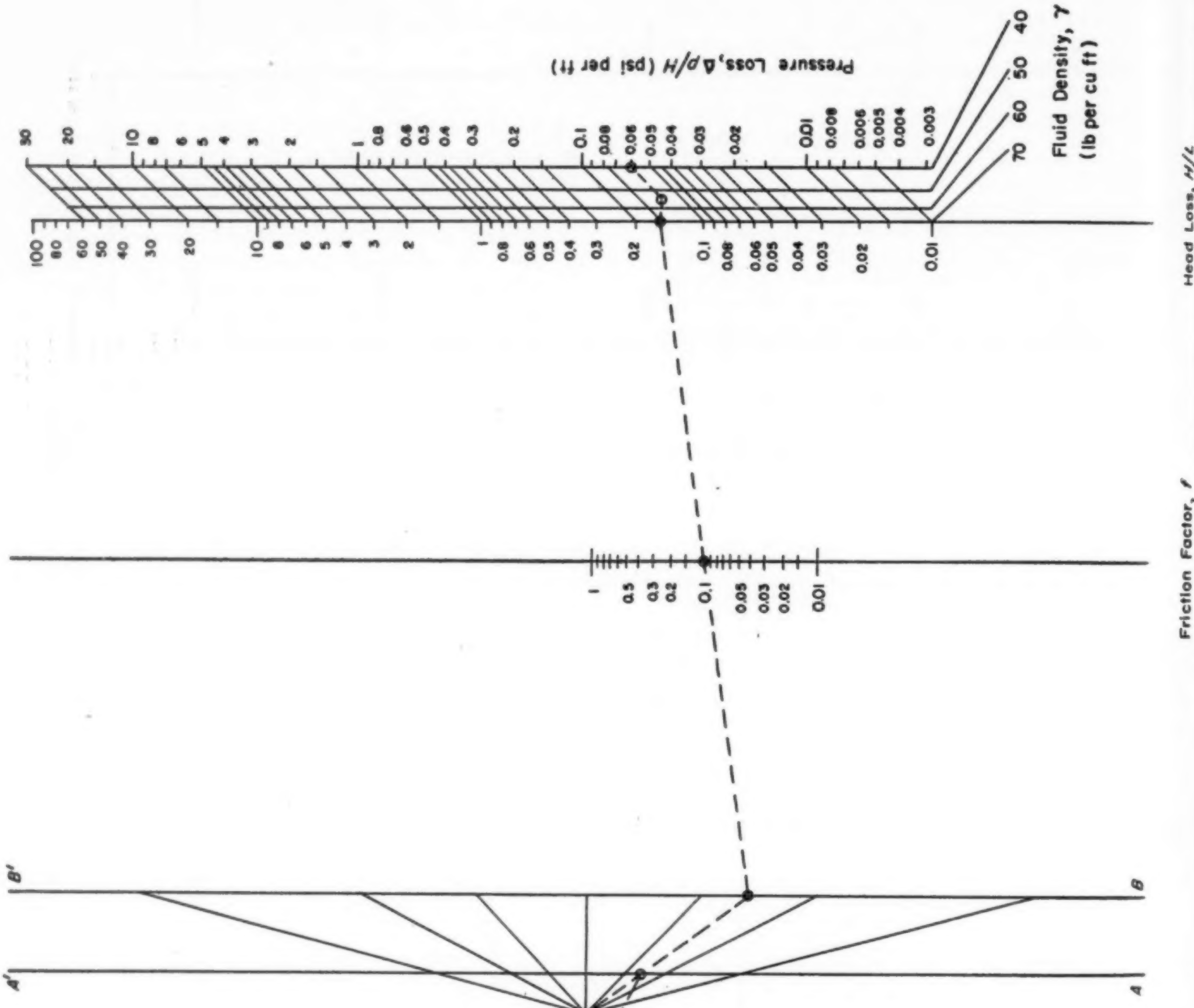


Fig. 3—Nomogram for finding loss in pressure or head

Simplifying Servomechanism Design

DESIGN ABSTRACTS

Co-ordinated analysis of design components can be achieved by systematic approach using block diagrams

By John M. Embree and Stephen P. Higgins, Jr.

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DESIGN of complex precision devices for quantity production raises many problems. Such devices are rarely the work of a single designer, but usually involve the co-ordinated efforts of many specialists with different technical backgrounds. Familiar components must be used most effectively and it is often necessary to develop or purchase new components in order that the overall device meets specifications. Since performance depends critically on certain components, it is essential that the individuals involved have a full appreciation of the overall problem. Further, it is essential that the details not be abscured by the overall problem.

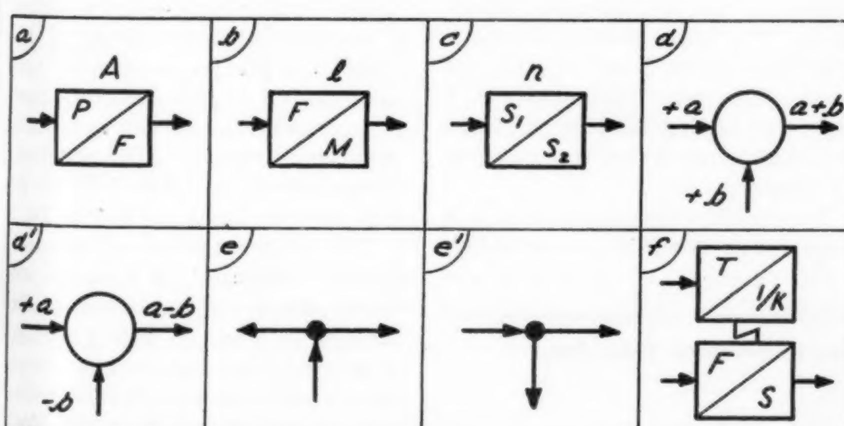


Fig. 1—Typical block symbols, explained in the accompanying text, indicate conversions of quantities and permit the diagramming of complex devices in terms of fundamental design components

Although the use of blocks to designate components of systems is well known, it is believed that heretofore the potentialities of the method as a design tool have been only partially developed. It is standard practice to draw a detailed block diagram of a system, combine the blocks, then describe overall system performance by means of the more compact block diagram. However, the basic components may be quickly buried in expressions and transfer functions which lend themselves to generalized analysis, but suffer from losing their individual identities. From the viewpoint of the designer or specialist, much is to be gained by reducing a device to basic blocks by a process just reverse to the usual one of combination.

Method of Approach: As suggested by H. Ziebolz ("Systematic Design of Mechanisms," MACHINE DESIGN, Dec. 1950, Page 126), an excellent starting point in a system or device design is the examination of possible intermediate translations or dimensional conversions. A translation (or dimensional conversion) occurs where there is a conversion from one quantity to another; for example, pressure to force.

The conversions represent basic design components. For instance, a diaphragm or bellows may convert fluid pressure to force and a spring convert force to displace-

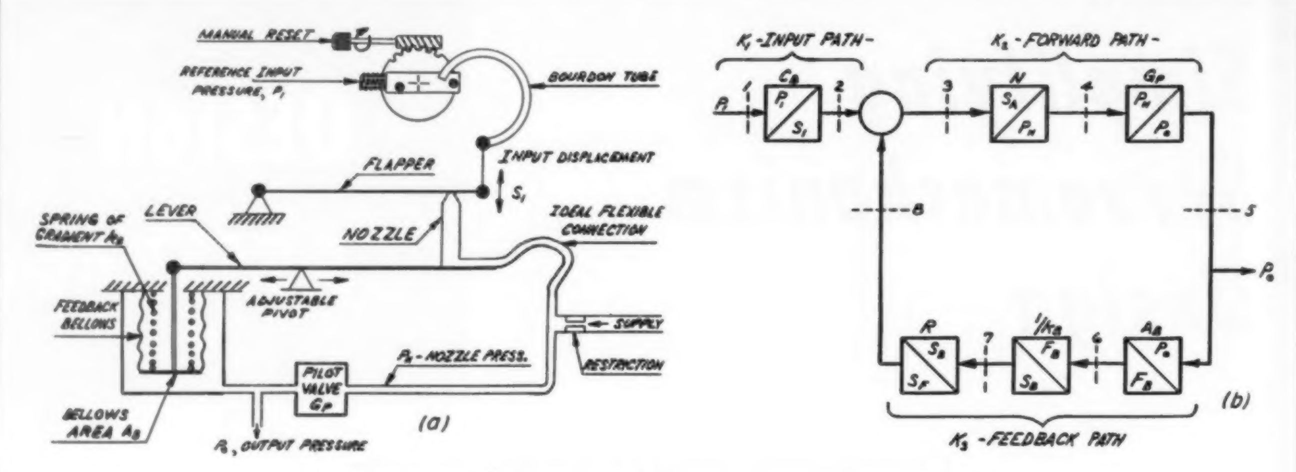


Fig. 2—Systematic analysis of the pressure transducer, *a*, is aided by a block diagram, *b*, which shows the various component functions

ment. A survey of possible combinations can be carried out rapidly and systematically if the data for design components are on cards indexed in tabular form. It is important to realize also that the reasons for choosing given conversions and elements are now subject to concise statement as is not the case when one relies on a less systematized approach.

Block Symbolism: At every point in the system where there is a conversion of one quantity into another, the conversion component is represented by a block. Above the block is indicated the area, length, radius, flapper-nozzle curve slope, inductance or deflection gradient by which the input to the block must be multiplied to obtain the value of the output. This is defined as the transfer function.

Within the block two symbols, separated by a diagonal line, are written to represent the nature of the input and the output. Some examples are shown in ***Fig.* 1**. When the blocks are connected together, the result is a diagram which defines the system.

In *Figs.* 1*a, b,* and *c,* the form of indicated conversions is shown. The *Figs.* 1*d* and *e* are in accordance with the current symbolism. In *Fig.* 1*f,* the broken line indicates that the transfer of energy or any other quantity between the two blocks is not of primary importance. The lower block indicates a conversion from force to displacement. The upper block shows that the ratio of displacement to force is a compliance which is a function of temperature.

To simplify the analysis, it has been found desirable to establish boundaries or stations between the summation circles and various blocks in the block diagram. The block in *Fig.* 1*g* shows boundaries in the form of dotted lines cutting across the transfer lines into and out of the block.

In order to have a comprehensive symbolic method of representing systems by basic blocks, some active elements must be included whose effect in the system is not as simple to visualize as that of the passive elements or the simple converting elements. For example, power amplifying elements such as a pneumatic flapper-nozzle, a hydraulic jet-pipe, or a vacuum- tube amplifier all require auxiliary power to provide the energy to produce an output signal. The auxiliary power supply is denoted by an arrow into the block, as in *Fig.* 1*h*.

The representation of dynamic forces is essential for dynamic stability analysis of mechanisms. Examples in *Figs.* 1*i* and *j* portray how damping and inertia forces can be shown in a block form which can be simply added to the block diagram at the points where their effect occurs in the device. In *Fig.* 1*i*, a displacement S is converted into a damping force F by means of the operator $p = d/dt$ and the viscous friction constant B. In *Fig.* 1*j*, a displacement S is converted into an inertia force F by means of the operator $p^2 = d^2/dt^2$ and the mass M. For static analyses, these blocks may be neglected.

Table 1—Parameters of Pressure-to-Pressure Transducer

P_1 = Reference input pressure, psi
S_1 = Input (displacement), in.
C_B = Bourdon tip displacement per unit pressure, in. per psi
S_F = Primary feedback (displacement), in.
S_A = Actuating signal (relative flapper-nozzle displacement), in.
P_N = Nozzle pressure, psi
N_N = Flapper-nozzle curve slope, psi per in.
P_o = Output pressure, psi
G_P = Gain of pilot relay valve, psi per psi
F_B = Force of pressure on feedback bellows, lb.
A_B = Effective area of the feedback bellows, sq in.
S_B = Displacement of feedback bellows, in.
R_B = Deflection gradient of feedback bellows, lb per in.
R = Lever ratio of feedback linkage, in. per in.

Characteristics of Component Blocks: The component characteristics of interest to the designer include:

1. Input and output load characteristics
2. Linearity and gain
3. Dead zone and sensitivity
4. Hysteresis and internal friction
5. Drift
6. Effect of external or environmental factors such as ambient temperature, barometric pressure, stray fields or radiation, vibration, external forces, etc.
7. Effect of supply or auxiliary power variations
8. Degree of complexity and general suitability to application
9. Useful life under operating and environmental conditions
10. Efficiency in conversion, storage, or release of energy
11. Dynamic response expressed as a transfer function $KG(S)$ or $KG(\omega)$.

Transfer Function: The transfer function is, in common usage, that quantity by which input must be multiplied to obtain the output of the block. A transfer is that quantity which crosses a station or boundary between any two adjacent components of the block diagram. The dimensions and value of the transfer must be the same as those of the output of the preceding component and of the input to the following components, since these are identical. Using servomechanism terminology, the transfer function is expressed $KG(j\omega)$, where K is a frequency invariant and $G(j\omega)$ is a complex function describing the magnitude and phase relationship. For calculating static relationships in a system, the system is assumed to be in equilibrium. This assumption requires that:

1. The frequency impressed on the system or component through the input signal or through other disturbances approaches zero
2. Passive or energy-storage elements do not change in energy content
3. Active or energy-producing elements do not add energy to the system except to cancel out losses; for example, flapper-nozzle bleed or filament power.

The value of these assumptions is that the system is considered in a "live" or dynamic condition: it is merely specified that the rate-of-change of input and other disturbances acting on the system approach zero.

It is assumed for static analysis that changes in input are slow enough for static relationships to prevail. Hence, inertia, damping and other dynamic effects will be negligible. Also, the transfer functions $KG(j\omega)$ of the individual components become much simplified. Inasmuch as the frequency variant $G(j\omega)$ approaches the value, unity = 1, in many cases

(*Continued on Page* 260)

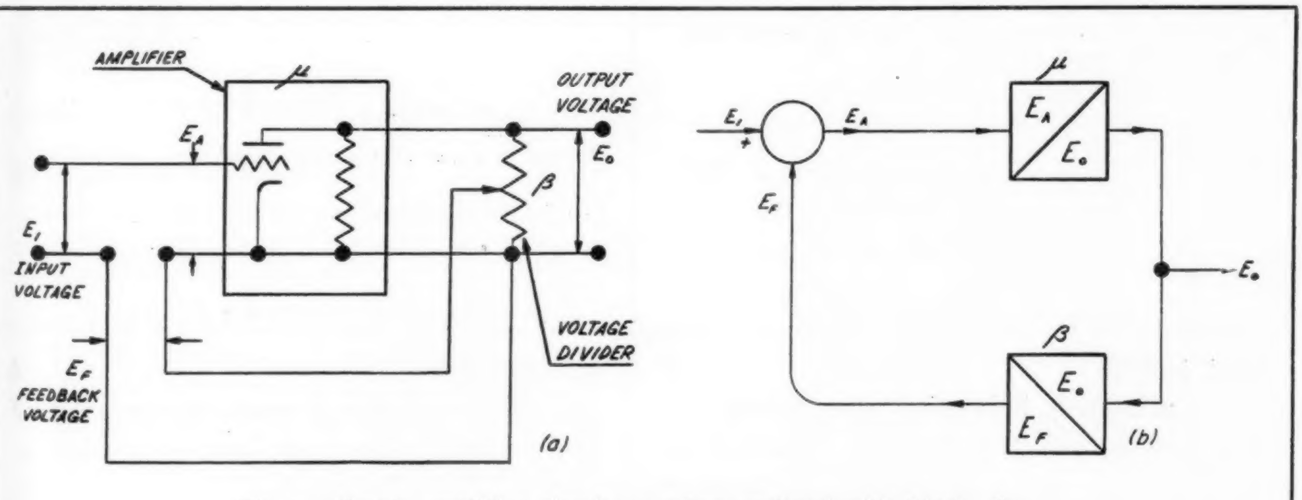


Fig. 3—Simple amplifier circuit, *a*, when analyzed with block diagram, *b*, shows fundamental similarity to pressure transducer of *Fig.* 2

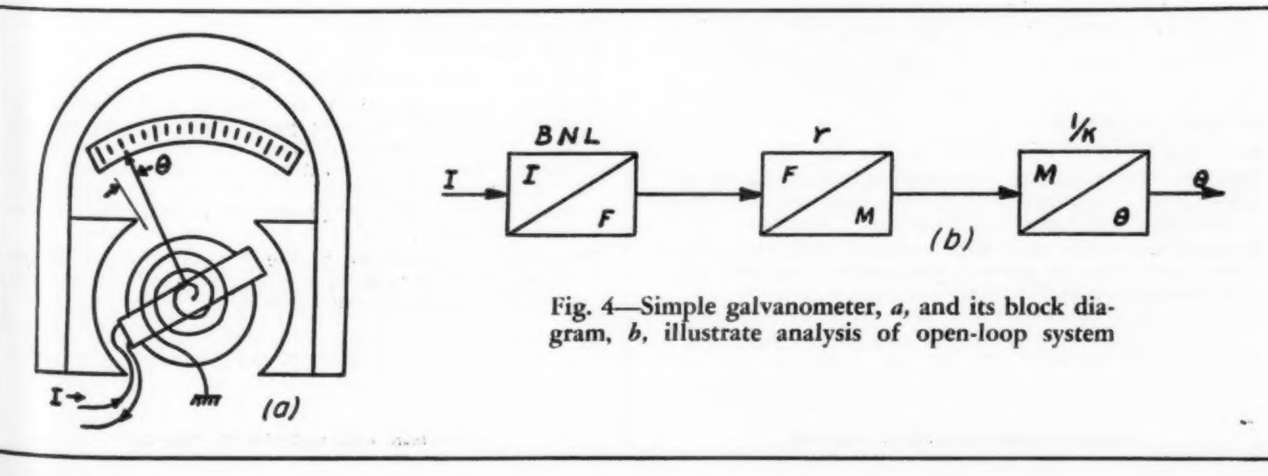


Fig. 4—Simple galvanometer, *a*, and its block diagram, *b*, illustrate analysis of open-loop system

NEW PARTS AND MATERIALS

. . . presented in quick-reference data sheet form for the convenience of the reader. For additional information on these new developments, see Page 205

WIRE SHAPES 1

. . . in bright annealed stainless steel

Pittsburgh Rolling Mills Inc., 524 *Grant Bldg., Pittsburgh* 19, *Pa.*

Nonstandard shapes, and shapes to specifications, are available.

Size: Flat wire from 0.010 to 0.125-in. thick, 0.050 to 0.375-in. wide; round and square edge wire from 0.050 to 0.150; half-rounds in cotter-pin sizes; keystone shapes; wire shapes to specifications.

Service: As stock for parts requiring corrosion resistance or attractive finish.

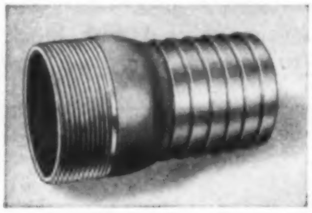
Design: Bright-annealed stainless steel; uncoated welding rod wire available.

For more data circle MD 1, Page 205

HOSE NIPPLE 2

. . . of smooth, lightweight steel tubing

Hose Accessories Co., 2700 *N.* 17*th St., Philadelphia* 32, *Pa.*



Hose shanks are made to fit straight-end hose, eliminating the need for enlarged-end hose.

Designation: 650-SC.

Size: For 1 to 6 in. pipe sizes.

Service: Attachment of hose to standard pipe systems; leakproof; accurate hose-shank diameter for easy insertion; inside surface is clean and free from scale.

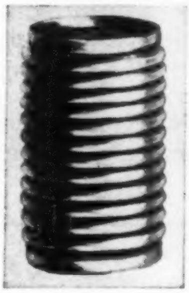
Design: One-piece unit with reduced hose end, made from steel tubing; plain or rustproofed; available also in brass or malleable iron.

For more data circle MD 2, Page 205

SEAMLESS BELLOWS 3

. . . withstands high working pressures

Clifford Mfg. Co., 118 *Grove St., Waltham* 54, *Mass.*



Former limitations on pressure ratings are removed.

Size: 9/16 in. OD nominal.

Service: For working pressures to 3600 psi; resist corrosion.

Design: Formed of stainless steel tube; seamless.

For more data circle MD 3, Page 205

ALUMINUM PAINT 4

. . . protects metal at temperatures to 1600 F

Sheffield Bronze Paint Corp., 17814 *Waterloo Rd., Cleveland* 19, *O.*

This paint becomes an integral glaze at temperatures above 800 F.

Designation: Super-Hot.

Form: Liquid.

Size: 1 qt, 1 and 5 gal cans; 55 gal drums.

Service: Protecting metal surfaces at temperatures to 1600 F; will not discolor, peel, blister or "brown off" at high temperatures; weather-resistant; anti-corrosive; turns brighter at higher temperatures with maximum brilliance at 1600 F; can be applied to cold, warm, slightly greasy or oily surfaces; airdries in 30 min.

Properties: Aluminum pigment plus solvent; transforms from peripheral coating of paint to integral aluminum glaze at about 800 F.

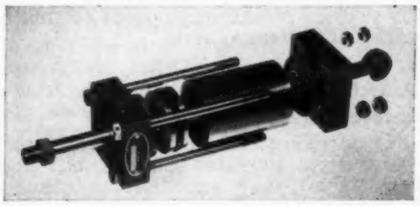
For more data circle MD 4, Page 205

NEW PARTS AND MATERIALS

AIR CYLINDERS 5

. . . feature oil-impregnated plastic heads

John D. Bachman & Co., Bristol, Tenn.



O-ring seals at the barrel ends provide leakproof construction and simple maintenance.

Size: 2 and 3 in. diam; strokes to 10 ft.

Service: For air pressure to 300 psi; can be adapted for oil or water; long oil-impregnated plastic bearing surface for rods provides low friction and long life; lightweight.

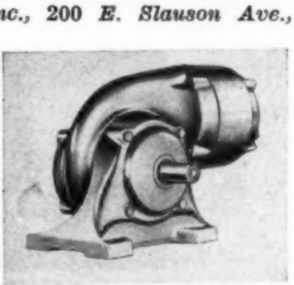
Design: Single or double-acting with oil impregnated Micarta plastic end pieces; O-rings act as piston, barrel-end and rod seals; standard mountings, and cushioned or noncushioned construction available; brass piston and steel rods and barrel are standard, other materials special.

For more data circle MD 5, Page 205

RIGHT-ANGLE GEARMOTOR 6

. . . cantilever base avoids misalignment

U. S. Electrical Motors Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.



By mounting motor and gears on a single supporting base, skewing of shaft, stress or warpage caused by uneven mounting surfaces are avoided.

Designation: GW.

Size: 3-Phase, 1/3 to 3 hp; single-phase, ¼ to 1 hp.

Service: Speeds from 20 to 155 rpm at gear ratios up to 58 to 1; long motor life and positive alignment due to cantilever housing design; positive lubrication from lubricant bath with worm above normal oil level to prevent churning; pyramid design base provides firm support.

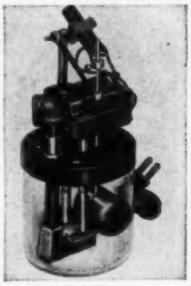
Design: Worm-gear reduction; available as GW—upright motor or horizontal motor with reversible (right or left) output shaft, GWR—single-phase equipped with capacitor, VA-GW—combination with V-belt variable-speed drive, and GWV—flange-mounted (footless) for direct connection vertically or on side with shaft right or left; hardened (Rockwell 55/60) worm with bronze-alloy gear and cast-iron hub; worm thrust taken by deep-groove ball bearing; ball bearings throughout; mechanical shaft seals with carbon end-face motor seal; centrifugally cast rotor; asbestos-protected windings.

For more data circle MD 6, Page 205

CONDENSATE PUMP 7

. . . collects and pumps liquid to drain

Samuel S. Gelber Co., 162 N. Clinton St., Chicago 6, Ill.



When jar is filled, the pump motor is automatically switched on.

Size: Diam, 3½ in.; height, 7½ in.; outlet, ⅛-in. IPT; weight, 2½ lb; jar capacity, 1 pt.

Service: Collecting and pumping out condensate liquid; capacity 75 gph at 0 lift, 10 gph at 3 ft lift.

Design: All-bronze miniature condensate pump driven by 2 pole, shaded-pole, continuous duty, single-phase 1/90-hp motor operating on 110 v, 60-cycles ac; glass jar with plastic cover; float operates miniature mercury switch which causes pump to operate; outlet may be used with standard pipe or rubber tubing; cord and plug included.

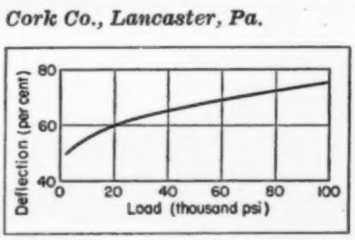
Application: Recirculating systems; evaporative coolers; humidifiers; air washers; agitators.

For more data circle MD 7, Page 205

FIBER GASKET MATERIAL 8

. . . saturated with synthetic rubber

Armstrong Cork Co., Lancaster, Pa.



New beater-saturation method of coating fibers before forming of sheet gives the sheet a homogeneous quality with high compressibility.

Designation: Accopac.

Form: Two forms—cellulose fiber and finely ground cork saturated with synthetic rubber, and chrysotile asbestos with Buna N synthetic rubber binder.

Size: Asbestos sheet, rolls or ribbon in $\frac{1}{64}$, $\frac{1}{32}$ and $\frac{1}{16}$-in.; cellulose type in same thickness plus $\frac{3}{32}$-in.; 50 sq yd per roll in thicknesses under $\frac{1}{16}$-in.; 25 sq yd per roll in $\frac{1}{16}$ and $\frac{3}{32}$-in. thickness; also available as die-cut parts.

Service: As gaskets or flange seals; high compressibility, giving excellent sealing under light flange pressures; will not rupture or crush under flange loads of 100,000 psi; for liquids or gases at temperature to 250 F with cellulose, 750 F with asbestos; will not dry out, harden or shrink on aging or in service.

Properties: Homogeneous and uniform with high flexibility; asbestos type has compressibility of 30-35% under load of 2800 psi; different types of fibers, saturants and fillers can be used.

For more data circle MD 8, Page 205

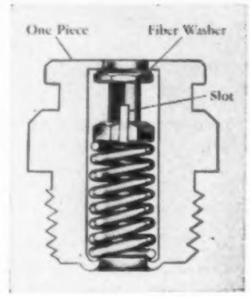
NEW PARTS AND MATERIALS

GREASE FITTINGS 9

. . . contain check to prevent leak-back

Universal Lubricating Systems Inc., Oakmont, Pa.

One-piece body construction is employed on these large buttonhead fittings to withstand high pressure.



Designation and Size:

Part	Height (in.)	Thread (pipe, in.)	Part	Height (in.)	Thread (pipe, in.)
2600	1⅛	⅛	2616	1⅜	⅜*
2605	2 1/32	⅜	2620	1 3/32	½
2610	1 3/16	¼	2625	1 5/16	⅝-18†
2615	1⅜	⅜			

* Undersize thread. † National Fine thread.

Service: Provides high grease flow without leaking; withstands extreme pressure and jolting.

Design: Buttonhead; one-piece body containing inner steel spring and fiber-washer check valve, flush top.

For more data circle MD 9, Page 205

CHROME CARBIDE 11

. . . corrosion, erosion, abrasion resistant

General Electric Co., Carboloy Dept., Detroit 32, Mich.

Made by powder metallurgy, parts of this metal are lightweight and nonmagnetic.

Designation: 608.

Form: Sintered metal.

Service: For parts requiring abrasion resistance (somewhat lower than tungsten carbide, but higher than hardened steels), and excellent resistance to corrosion; nonmagnetic; retains metallic luster after 30% salt spray for 750 hr; resists sulphuric, hydrochloric acids, sodium hydroxide and almost completely inert to lactic and citric acids; slight surface discoloration after 24 hr at 1850 F in air; high erosion resistance; can be molded to shape, machined in presintered condition, or ground, lapped and polished with silicon carbide wheels or diamond grinding wheels and lapping compounds; can be brazed if given flash nickel plate, or cemented with ethoxyline resins for low-temperature, medium-strength joints.

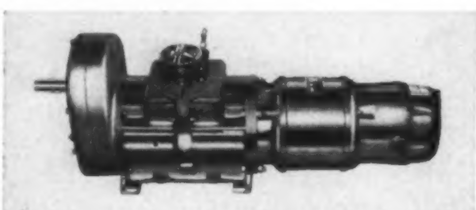
Properties: Sintered metal containing 83% chrome carbide, 2% tungsten carbide and 15% nickel; hardness, Rockwell 88A; density, 7.0 gm per cu cm; transverse rupture strength, 100,000 psi; coefficient of thermal expansion, 6.4×10^{-6} in the range 70 to 1292 F (approx equivalent to steel).

For more data circle MD 11, Page 205

VARIABLE-SPEED DRIVE 10

. . . with built-in brakemotor

Graham Transmissions Inc., 3754 *N. Holton St., Milwaukee* 12, *Wis.*



This transmission is especially suitable for indexing and positioning work.

Size: ¼, ½, ¾, 1, 1½, 2 and 3 hp.

Service: Provides fast stopping plus infinite speed ratio and exact speed holding; built-in overload protection to prevent damage in case of a jam; mounts with 4 bolts.

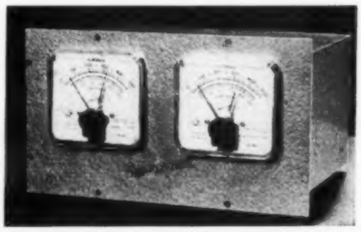
Design: Cone-and-ring variable speed transmission with built-in brakemotor, with or without worm or helical-spur reduction; micrometer, lever or remote electric control; brake is direct-acting disk type connected in parallel so that starting the motor energizes the brake magnet coils and releases the brake; stopping the motor de-energizes coils causing spring pressure to be applied to brake disks.

For more data circle MD 10, Page 205

DOUBLE CONTROL 12

. . . for temperature, voltage or current

Assembly Products Inc., Main at Bell St., Chagrin Falls, O.



Two separate units can be controlled by this "twin."

Size: 10 7/16 in. wide, 6 in. high, 8¾ in. deep.

Service: Controlling temperature (ranges from −200 F to 3000 F available), voltage or current; can control on less than 1 microamp input to 3000 ohm in most sensitive range; double-contact meters turn power on and off to hold temperature and at the same time give safety shutoff for over and under temperature; quick-disconnect plug to remove unit from service without long interruption of controlled process.

Design: Direct-contact, with input going direct to indicating winding of contact meter; meter contacts close circuit to single-pole, double-throw load relay rated at 15 amp, 115 v ac noninductive; automatic interrupter releases meter contacts every 3 to 5 sec to sense input.

Application: Injection molding machines; compression molding presses; heated forming dies; rubber platens; furnaces; ovens.

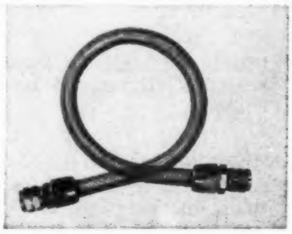
For more data circle MD 12, Page 205

NEW PARTS AND MATERIALS

FLEXIBLE PLASTIC TUBING 13

. . . with stainless-steel outer braid

U. S. Stoneware Co., Akron 9, O.



Reinforced with braided stainless, this chemically resistant tubing withstands relatively high pressures and readily absorbs vibration.

Designation: Tygon.

Size: ¼ and ⅜-in. ID.

Service: Will not crack, leak or break at pressures to 300 psi; handles highly corrosive liquids, gases or semisolids; absorbs vibration; flexible for easy installation; permits visual inspection.

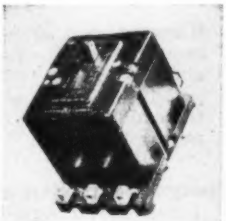
Design: Translucent plastic tubing enclosed with triple-wire stainless-steel braid; plastic tubing available in 6 formulations for various service conditions; stainless-steel crimped fittings, field-applied on ¼-in. size, factory-applied on ⅜-in.; other sizes available as specials.

For more data circle MD 13, Page 205

CIRCUIT BREAKER 14

. . . plugs into base without connecting wires

General Electric Co., Trumbull Electric Dept., 41 *Woodford Ave., Plainville, Conn.*



Breakers can be removed and a spare plugged in with minimum interruption to system.

Designation: K-173.

Size: 4⅛ in. long, 3 11/32 in. wide, 4⅛ in. deep (not including base).

Service: Overload and short-circuit protection with interrupting capacity of 5000 amp ac or dc; for 125 v 60-400 cycles ac, or dc; trip element and continuous current ratings, 10, 15, 20, 25, 30, 35, 40 and 50 amp; quickly removed and replaced without disconnecting any line or load wire; trip-free overload operation; for ambient temperatures to 50 C; class HI shock resistance; meets specification MIL-C-1939.

Design: Three-pole with thermal protection in outer poles; formed-copper female drawout terminals in breaker fit over silver-plated copper stabs on base; breaker is held in place by 2 mounting bolts; inverse time overload protection; base and breaker case, asbestos phenolic; single or double bases available; double bases can be arranged in close panel-board; nonautomatic breakers without protective devices are available; handle locking latch available.

For more data circle MD 14, Page 205

METAL DECALS 15

. . . attached with adhesive cement

C & H Supply Co., 115 *Administration Bldg., King County Airport, Seattle* 8, *Wash.*

These paper-thin decals can be secured to any smooth surface.

Designation: Metal-Cal.

Size: 0.003-in. thick; sizes from ⅛ x ⅛-in. to 9 x 13 in.

Service: Fasten to metal, glass, porcelain or wood; cement is protected with cellophane until ready for use; applied quickly; sticks solidly; abrasion resistance, 18,000 wearing cycles in Tabor abrasion test in comparison with 1000 for paper decals; printed in any colors desired.

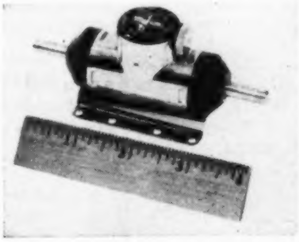
Design: Sheet aluminum with adhesive cement covered by cellophane; printed by standard offset process; anodized for permanent retention of printing.

For more data circle MD 15, Page 205

MINIATURE SPEED CHANGER 16

. . . has wide overall ratio

Metron Instrument Co., 432 *Lincoln St., Denver* 9, *Colo.*



Extremely small, this variable-ratio transmission weighs less than 6 oz.

Designation: 3A

Size: 2 23/32 in. long plus 23/32-in. shaft extention both ends, 1 27/32 in. high, 1½ in. wide.

Service: Variable-speed control with overall ratio range of 25:1 (5:1 above and 5:1 below input speed); nominal max output, 0.025-hp; nominal slip at rated output, 9%; max speed (either shaft), 20,000 rpm; rotation in either direction; zero backlash.

Design: Disk and roller; 2 drive disks contact 2 rollers, which are pivoted to contact disks at changeable radii; adjusting knob has friction drag to prevent drift in setting; lever, push-rod, spur-gear, miter-gear and worm-gear speed controls are available; dial pointer indicates ratio; sealed construction, with shielded ball bearings.

Application: Business machines; cameras; computers; controllers; recorders; servomechanisms; timers.

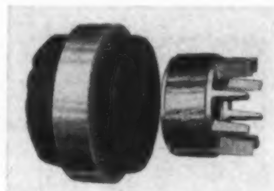
For more data circle MD 16, Page 205

NEW PARTS AND MATERIALS

SHELL-TYPE MOTORS 17

. . . give unlimited mounting versatility

Reuland Electric Co., 3001 *W. Mission Rd., Alhambra, Calif.*



Mounted integrally as part of the machine, these motors can streamline appearance and shorten overall length.

Size and Service: Single-phase,—¾, 1, 1½, 2, 3 and 5 hp in speeds of 3600, 1800 and 1200 rpm; polyphase—same hp plus 7½, 10, 15 and 20 hp at same speeds plus 900 rpm; single phase for 115/230 v, 60 cycle ac; 2 or 3-phase for 208, 220/440 or 550 v, 60 cycle ac; can be housed within machine frame; overall length is shortened; high mounting versatility.

Design: Stator, plus shaftless rotor; armored stator with Formvar copper wire, heavy slot cell insulation and tied-down coil extensions; entire stator baked in Bakelite varnish to solid unit; pressure-cast aluminum rotor, including rotor bars, end rings and fans.

For more data circle MD 17, Page 205

DRAWN BOXES 18

. . . for cases, chassis or housings

Zero Mfg. Co., 1121 *Chestnut St., Burbank, Calif.*

Standard sizes are available, as well as boxes fabricated to specifications.

Size: Standard sizes as follows;

Type	Length (in.)	Width (in.)	OD (in.)	Height (in.)
Aluminum boxes.......	2-15½	1 3/16-6½	—	½-4¾
Aluminum cans	—	—	⅝-5 3/16	1-2½
Steel boxes	2	1¾	—	1½-2¾
Steel cans	—	—	1½-2½	1½-2¾
Brass boxes	4 15/16	2 15/16	—	1½ 2¾

Service: As electronic and radar assembly chassis; instrument dial and gage boxes, junction and coil boxes, electric assembly cases and housings; smooth finish free from tool marks, warpage and minor defects.

Design: 2S aluminum, steel or brass boxes or cans having radii on edges; 3S-H14 aluminum covers for aluminum boxes, also covers for brass and steel boxes; hermetically sealed cans available; aluminum has smooth satin finish; can be fabricated to requirements and furnished complete with installed fasteners, punched holes and mounted brackets.

For more data circle MD 18, Page 205

SYNTHETIC O-RINGS 19

. . . handle Freon refrigerants and oils

Parker Appliance Co., 17325 *Euclid Ave., Cleveland* 13, *O.*

Fluids difficult or impossible to handle in rubber-sealed systems can be handled with these new O-rings.

Designation: 614-1.

Size: Dynamic-seal series—88 standard sizes from 1/16 to ¼-in. ring width, ¼ to 16 in. OD; static-seal series—⅛-in. ring width, 1⅞ to 10¼ in. OD; special sizes and molded shapes available.

Service: For sealing Freon, oils and low aniline point oils used in refrigeration; volume change after 70 hr immersion at room temperature as follows:

Medium	Change (%)	Medium	Change (%)
Freon 12*........	13	Glacial acetic acid..	22
Freon 22*........	15	Turpentine	4
Freon 13B1	0	EP lubricant	2

*Liquid phase.

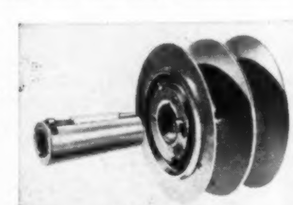
Design: Molded from synthetic rubber compound; hardness (Shore A), 70 deg; tensile strength, 2000 psi; elongation, 250%.

For more data circle MD 19, Page 205

ADJUSTABLE-PITCH SHEAVES 20

. . . lock on shaft with split tapered bushings

Allis-Chalmers Mfg. Co., 1001 *S. 70th St., Milwaukee* 1, *Wis.*



Sheaves can now be mounted on the motor shaft so the pitch-adjusting screw is either toward or away from motor bearing.

Designation: Vari-pitch (sheaves); Magic-Grip (bushings).

Size and Service: Quick installation or removal on motor shaft; adjustable while stationary, stopping or overload stresses do not affect sheave setting; less weight on motor bearings, since sheaves are 20% lighter than former style wide-range sheaves;

Pitch Diam (in.)	Motor* (hp, max)	Belt Section	Stock Bores (in.) 1 groove	2 groove	3 groove
4.0 to 7.5	5	Q	⅞	1, 1⅛	....
5.0 to 8.5	7½	Q	..	1, 1⅛	....
5.25 to 10.0	15	R	..	1⅛, 1⅜, 1⅝	....
6.25 to 11.0	25	R	..	1⅝	1⅞, 2⅛
7.25 to 12.0	30	R	..	1⅝	1⅞, 2⅛

*At 1750 rpm.

Design: Adjustable pitch; bushing consists of 2 split, tapered sleeves, one within the other; when locking screw is tightened, outer sleeve clamps against disks to lock mechanism, and inner sleeve clamps on shaft; all torque is transmitted by keys; disk spacing (pitch adjustment) is effected by turning adjusting screw while locking screw is loosened.

For more data circle MD 20, Page 205

NEW PARTS AND MATERIALS

POWER SPRINGS 21

. . . with improved characteristics

Sandsteel Spring Div., Sandvik Steel Inc., 145 *Hudson St., New York* 13, *N. Y.*

By using a special steel and annealing procedure, a longer, thinner spring has been designed providing more prewind and reserve power.

Size: 3/8 in. wide, 0.025 to 0.42 in. thick, 6 to 12 in. long.

Service: As power or recoil-type starter springs; provide large prewind and reserve power; retain resiliency and tension, and will not set even after long use.

Design: High-carbon steel spring in holder.

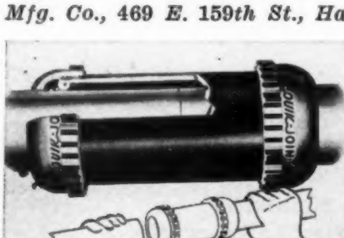
Application: Gasoline engines; portable power saws; power lawn mowers; small tractors.

For more data circle MD 21, Page 205

PIPE COUPLINGS 22

. . . join pipe without threading

Quik-Joint Mfg. Co., 469 *E.* 159*th St., Harvey, Ill.*



Pipe ends are inserted into the coupling body and locknuts wrenched to desired tightness.

Designation: ST.

Size: 1/2, 3/4, 1, 1 1/4 and 1 1/2 in. IPS.

Service: Pipe connection for pressures up to 2000 psi; for gas, water, air or oil; can be completely installed in less than 60 sec; allow up to 7 deg linear deflection; absorb shock and vibration; may be disassembled at any time.

Design: Pipe-steel body with cold-rolled steel locknuts and gasket retainers; gaskets can be plain GR-S synthetic or silicone rubber, Neoprene, or Thiokol; pipe ends are inserted in coupling and locknuts are tightened to compress gasket tightly around pipe; available as straight couplings, 90-deg or 45-deg ells, male adapters, or welded adapters.

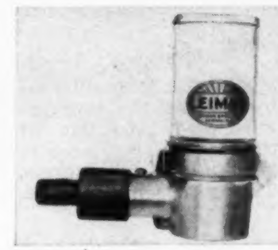
For more data circle MD 22, Page 205

AUTOMATIC OILER 23

. . . actuated by air flow

Leiman Bros. Inc., 146 *Christie St., Newark* 5, *N. J.*

Feeding measured amounts to air pumps, this oiler feeds only when pump is running.



Designation: E-113.

Size: 4 1/4 in. deep, 3 9/16 in. wide; reservoir holds 3 oz.

Service: Adjustable feed from 1 drop in 4 min to 4 drops per min of SAE 10 to SAE 70 oil; feeds only when pump is running; can be used on vacuum pump or inlet of pressure pump at from 1/2 to 2 in. vacuum or 10 psi pressure; heat insulator prevents pump heat from warming and thinning oil in reservoir.

Design: Drop feed, actuated by air flow; transparent visual reservoir, hinged for refilling.

For more data circle MD 23, Page 205

SMALL PUSHBUTTON SWITCH 24

. . . sealed at panel against oil or water

Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

The pushbutton plunger mechanism is sealed at the panel to protect the switch unit behind the panel.

Designation: 1PB3.

Size: 31/32 in. long, 3/4-in. wide (across hex bushing flats), 1 3/16 in. high; weight, 0.06-lb; max panel thickness, 3/32-in.

Service: Listed by Underwriters' Laboratories at 5 amp at 125 to 250 v ac, 2 amp at 30 v dc (resistive, motor or inductive load at sea level) or 1 1/2 amp at 50,000 ft; sealed against oil, water and dirt at panel; ice formation is prevented by plunger, seal and bushing design; switch elements snap into mounting bracket, and can be assembled after wiring; operating force, approx 2 lb; contact break distance, 0.010-in. min.

Design: Single or double-pole, double-throw; panel-mounted pushbutton is sealed with synthetic sponge-rubber, through which the pushbutton operates a subminiature snap-action switch; O-ring gasket furnishes seal where hex bushing meets the panel; exposed surfaces are finished in lusterless olive-drab lacquer.

For more data circle MD 24, Page 205

NEW PARTS AND MATERIALS

HEATER SWITCHES 25

. . . provide simple wiring method

Hart Mfg. Co., 206 Bartholomew Ave., Hartford, Conn.

Hookup is accomplished by pushing the stripped wire end into one of the switch's automatic locking connections, saving assembly time.

Designation: 850.

Size: $1\frac{23}{32}$ in. wide, $1\frac{23}{32}$ in. high, $1\frac{7}{16}$ in. deep with $\frac{53}{64}$-in. shaft extension.

Service: For on-off, 3, 5, 7 or 9-heat circuits, or special combinations; rated 15 amp at 125-240 v ac; UL-approved

Design: Flush-panel mounted, 3-wire; stripped end of stranded or solid wire is pushed into connector and automatically locked by spring clamp; release is effected by depressing lever; 1 or 2-hole or special mounting arrangements.

Application: Ranges; heaters; appliances.

For more data circle MD 25, Page 205

HOLLOW BARS 27

. . . of graphitic tool steel

Timken Roller Bearing Co., Steel & Tube Div., Canton 6, O.

Possessing excellent machining properties, this type of steel has good resistance to wear and abrasion.

Designation: Graph-Mo Hollow-Bar.

Form: Turned and bored bar section.

Size: 4 in. to 16 in. OD; $1\frac{1}{2}$ to 10 in. ID, respectively; lengths approx. 7 to 14 ft.

Service: Resists wear and abrasion; nonseizing, since graphite pockets retain lubricant; excellent machining properties; hardness of Rockwell C-56/66 can be obtained with approx 1475 F heat treatment followed by oil quench.

Properties: Graphitic tool steel with composition of C 1.45, Mn 1.00 max, P 0.025 max, S 0.025 max, Si 1.25 max, Mo 0.25, rest Fe; properties as follows for various draw temperatures;

Draw (F)	Hardness (Rockwell C)	Izod* (ft-lb)	Yield Point† (thousand psi)	Ultimate† (thousand psi)
300	63	19	...	...
600	58	28	...	...
900	46	75	198	220
1000	40	94	172	195
1100	36	113	140	163
1200	26	120	180	130
1300	13†	...	75	97

* 0.394-in. square bars, unnotched. † Approximate.

Application: Bushings; cams; cutters and knives; rolls; selector fingers.

For more data circle MD 27, Page 205

PHENOLIC PLASTIC 26

. . . noncorrosive to electric contacts

Durez Plastics & Chemicals Inc., N. Tonawanda, N. Y.

Corrosion of silver contacts due to a chemical commonly used in many phenolic plastics is claimed to be eliminated.

Designation: 15528 Black.

Form: Granular molding material.

Service: General-purpose material having same properties as comparable phenolics; for continuous temperatures below 300 F; will not cause corrosion of silver contacts; available in soft plasticity for easy flowing; preforms readily in automatic machines; may be preheated by conventional methods; has somewhat shorter storage or shelf life before processing.

Properties: Flock and wood-flour-filled phenolic; average (except where noted) properties of compression-molded specimens as follows:

Property	Value	ASTM Test
Specific gravity	1.38	D792-48T
Water absorption (%)	1.0 max	D955-48T
Impact strength* (ft-lb per in.)	0.28 min	D256-47T
Flexural strength* (psi)	10,000 min	D790-47T
Tensile strength* (psi)	7500 min	D638-49T
Compressive strength* (psi)	26,000 min	D695-49T
Modulus of elasticity, tension* (million psi)	1.2	D638-49T
Hardness (Rockwell M)	110	D785-48T
Dielectric strength (v per mil)		D149-44
short time†	325 min	
step by step†	250 min	
Volume resistivity (ohm-cm)	1×10^{11} min	D257-49T
Dissipation (power) factor		D150-47T
60 cycle*	0.05	
1 megacycle*	0.04	
Dielectric constant		D150-47T
60 cycle*	6	
1 megacycle*	5	

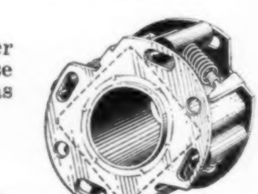
*48 hr at 50 C. †48 hr, 50% relative humidity at 25 C.

For more data circle MD 26, Page 205

MINIATURE CLUTCH 28

. . . free-wheeling, for one-way motion

High Precision Inc., 375 Morse St., Hamden, Conn.



This tiny one-way roller clutch can be used for precise transmission of power, or as a backstop.

Designation: Miniclutch.

Size and Service: As free-wheeling clutch or one-way brake; $\frac{3}{4}$-in. diam unit can be throttled down, when used as variable stroke ratchet, to a feed of less than 1/300 rev per stroke; low drag when free-wheeling; torque capacity varies with inertia of coupled parts, torsional and transverse vibration, rotational speed acceleration, precision of mounting and freedom from dust and dirt; sizes following are for complete unit;

Model	Bore and Shaft (max diam, in.)	Diam (in.)	Length* (in.)	Torque† (oz-in.) Light	Medium
CL-51	$\frac{1}{4}$	$\frac{13}{16}$	$1\frac{1}{8}$	10	30
CL-61	$\frac{7}{16}$	$1\frac{3}{16}$	$2\frac{3}{16}$	40	125
CL-71	$\frac{11}{16}$	2	$3\frac{5}{16}$	150	450

*Bored hub and housing, excluding shaft. †Nominal.

Design: One-way roller, including bored hub, housing, and shaft; sub-assembly of cam and roller assembly (shown) also available, consists of square cam bored as hub, 4 springs, 2 retainers; all steel, with hardened parts, bronze or roller bearings supplied for volume use.

Application: Recording instruments; business machines; motion-picture projectors; sewing machines; automatic vending machines; servomechanisms; lubricant pumps; control devices.

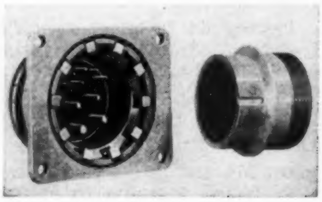
For more data circle MD 28, Page 205

NEW PARTS AND MATERIALS

BREAKAWAY COUPLING 29

. . . carries electric, fluid and gas lines

E. B. Wiggins Oil Tool Co. Inc., 3424 E. Olympic Blvd., Los Angeles 23, Calif.



Essentially a quick-disconnect electric coupling, this unit can also carry fluid lines in the same envelope.

Size: Custom built to accommodate standard inserts.

Service: Carrying electric, fluid or gas lines; breakaway point can be set by controlling spring tension; can be connected or disconnected with fingers, without wrench; working parts can be sealed off from water, ice, mud, sand and dirt; pressure-proofed to 750 psi.

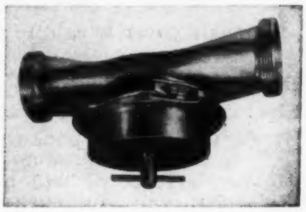
Design: Quick-disconnect; mating halves are pushed together to connect, pulled to disconnect; uses any standard inserts, such as Amphenol, Breeze, Winchester, Bendix, Scintilla, etc.; envelope configuration can be flange, ring, or any other shape; socket or nipple can be mounted permanently without affecting breakaway action.

For more data circle MD 29, Page 205

MAGNETIC TRAP 31

. . . has full flow over large magnet area

Tri-Clover Machine Co., Kenosha, Wis.



Pie-shaped magnet segments provide an increased number of gaps across which material can be trapped.

Size: 2, 3 and 4 in. OD.

Service: Removing tramp iron and stray metal from food and chemical products, oil and water; wide, flat, streamlined body design brings fluid over magnet segments at decreased velocity which aids trapping action and reduces agitation usually present in traps having a baffle.

Design: Permanent magnets in 4 or 6 pie-shaped segments, depending on size, which provide 4 or 6 gaps plus magnet center for trapping material; type 316 wrought stainless steel, unpolished or highly polished; pipe body, gasket and magnet are fastened together with easily removed ring clamp, closed with overcenter latch; available with Acme sanitary threads, Van Stone ends or IPS screw threads.

For more data circle MD 31, Page 205

TELLURIUM COPPER 30

. . . has high machinability, conductivity

Chase Brass & Copper Co., Waterbury 20, Conn.

Unlike leaded copper alloys, this alloy may be hot or cold worked.

Form and Size: Extruded shapes, or tube with round cross-section inside and hex or octagonal outside also available;

Form	Temper	Size (in.)
Round rod	Half hard	1/16 to 2⅝ diam
	Hard	1/16 to 1 diam
Hex rod	Half hard	1/16 to 1¼ across flats
Square bar	Half hard	1/16 to ¾ sides
Round tube*	All	⅜ to 3 OD
Round wire	⅛-¾ Hard	0.039 to 0.203 diam
	⅛-½ Hard	0.203 to 0.562 diam
	⅛-¼ Hard	0.562 to 0.750 diam

*Wall thickness, 0.049 to 0.500-in. for annealed or general-purpose, 0.049 to 0.250-in. for hard, depending on OD.

Service: Electrical conductivity, 90% of copper; machinability, 90% of free-cutting brass; excellent hot-working characteristics, good cold-working; high thermal conductivity; essentially same corrosion resistance as copper.

Properties: Alloy containing 99.5% copper, 0.5% tellurium; tensile strength, 38,000 to 42,000 psi in half-hard condition, 44,000 to 54,000 in hard condition, depending on form; hardness (Rockwell) averages 40-45B in half-hard condition, 45-50B in hard; density, 0.323-lb per cu in. at 68 F; modulus of elasticity, 17 million psi; thermal conductivity, 205 Btu per sq ft per ft per hr per deg F.

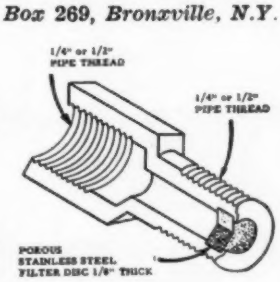
For more data circle MD 30, Page 205

PRESSURE SNUBBERS 32

. . . damp pulsations in fluids being gaged

Equipoise Controls Inc., P.O. Box 269, Bronxville, N.Y.

Rapid pulsations or vibrations are smoothed out to average values.



Size: ¼-in. SPT—¾-in. hex, 1½ in. long; ½-in. SPT—1⅜ in. hex, 1⅞ in. long; filter disk, ⅛-in. thick.

Service: Causes normal average pressure changes to be registered at gages, reducing wear or pressure shock; can filter small quantities of fluids, act as a metering device, or confine mercury in manometers; stainless steel bodies for 20,000 psi, brass bodies for 15,000 psi;

Grade	Service	Capacity (cfh)
G	Air, gases, gasoline, Freon, etc., having viscosity less than 1 SSU	1.1
E	Water, kerosene, light oils, etc., having viscosity from 3-300 SSU	3.0
F	Special applications of G and E	2.0
D	Oil, etc., having viscosity above 300 SSU	6.5
HX	Mercury manometers, diaphragm gages, etc.	0.4
HXX	Extreme damping, violent pulsations averaging from 2000 to 7000 per min	. .

*At 1 psi differential pressure.

Design: Brass or 18-8 stainless steel body with porous Type 304 stainless steel disk.

For more data circle MD 32, Page 205

NEW PARTS AND MATERIALS

CONVEYOR BELT 33

. . . has nonskid surface for steep inclines

Baldwin Belting Inc., 76 Murray St., New York 7, N. Y.

Nonskid cover is said to grip like the tread on a tire.

Designation: Tread-Top.

Size: $\frac{3}{16}$-in. thick; up to 48 in. wide.

Service: Conveying packages or articles up inclines of 25 to 30 deg, depending on type of article; nonskid cover; belt cover will not mark product, is easily cleaned; will run over pulleys as small as 2 in. diam; water-proof; minimum shrinkage; max temperature, 200 F; tensile strength, 700-900 lb per in. width; recommended loading, 70-90 lb per in. width; ply adhesion, 18-22 lb per in.

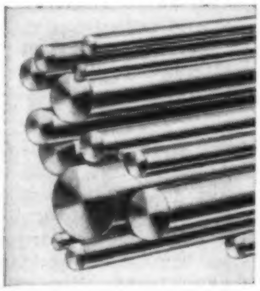
Design: Three-plies of 16-oz closely woven duck with 0.010-in. skim coat of natural rubber between plies and $\frac{3}{32}$-in. treaded cover of brown natural rubber; not folded and has no splices; can be joined with No. 25 alligator or No. 4 clipper lacing, or can be made endless with vulcanized multiple-step lap joint.

For more data circle MD 33, Page 205

LEADED STEELS 34

. . . free-machining for fast production

LaSalle Steel Co., 1412 150th St., Hammond, Ind.



One of these steels, available as bar stock, can replace brass where corrosion is not a factor.

Designation and Size: Super La-Lead, ⅜-in. through 1¼ in. rounds, ⅜-in. through 1 in. hexagons; Leaded TS 4140 Modified, ⅜-in. through 3 in. rounds, ⅜-in. through 1½ in. hexagons.

Service: Super La-Lead machines at speeds approaching those of brass, is intended as substitute on parts not subject to corrosion as well as regular steel applications; Leaded TS 4140 Modified machines ⅓ faster than comparable nonleaded grade, with approximately same heat-treating characteristics, hardenability and mechanical properties.

Properties: Composition of Super La-Lead is C 0.13 max, Mn 0.8-1.2, P 0.04-0.09, S 0.4-0.5, Pb 0.15-0.35, balance Fe; composition of Leaded TS 4140 Modified is C 0.39-0.47, Mn 0.75-1.05, P 0.04 max, S 0.04 max, Si 0.20-0.35, Cr 0.7-1.0, Mo 0.08-0.15, Pb 0.15-0.35.

For more data circle MD 34, Page 205

SYNTHETIC RUBBER PARTS 35

. . . handle hot oil or synthetic lubricants

Acadia Synthetic Products Div., Western Felt Works, 4035-4117 Ogden Ave., Chicago, 23, Ill.

Developed to meet specification MIl-R-7362, a new compound is used for applications where oil transmission lines are subject to high temperatures.

Designation: 56243.

Size: Molded parts to 20 in. OD by ⅜ to ⅝-in. thick; extruded sections to approx 2 x 2 in. cross section; die cut parts to ⅛-in. thick, approx 18 to 20 in. OD or square.

Service: As gaskets or parts to handle or seal greases or hot oils; meet specifications MIL-R-7362 and MIL-G-3278, also applicable parts of specifications MIL-L-7808, MIL-L-6085, MIL-L-6387 and MIL-O-6085; original properties as follows; Shore Durometer hardness, 65; tensile strength, 2330 psi; elongation, 320%; modulus of elasticity at 100% elongation, 410 psi.

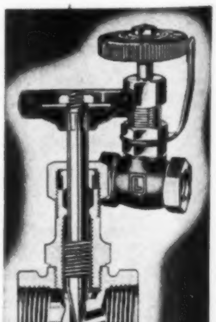
Design: Molded, extruded or die-cut of special synthetic rubber compound.

For more data circle MD 35, Page 205

NEEDLE VALVES 36

. . . gland type, for close flow control

Lunkenheimer Co., Cincinnati 14, O.



These gland-type valves are small and compact.

Designation and Size: 906 (bronze stem) and 907—⅛, ¼, ½, ¾ and 1 in. pipe sizes; 906 (steel stem)—⅛, ¼ and ½-in; 1565—¼, ⅜, ½-in; 1566—¼, ⅜-in.

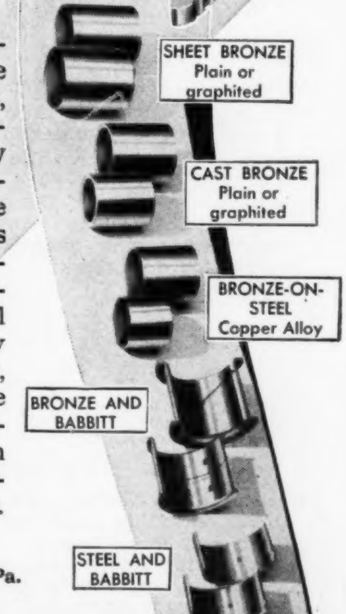
Service: Pin-point control of flow in small lines; handwheel is "nonslip" design, needle point and valve seat always accurately aligned.

Design: Gland-type bronze needle; 906 is globe type with bronze or cadmium plated carbon-steel stem; 907 is angle type with bronze stem; 1565 is globe indicator type, with serrated handwheel having numbered graduations on its face and spring clip to hold valve securely at setting; 1566 is angle indicator type, deep stuffing boxes with hexagon gland followers; steel stem design has smaller seat opening for finer reguation.

For more data circle MD 36, Page 205

The Answer to Lower Costs

SHOULD your application be difficult or impossible to lubricate, where excess oil may damage the product, where lubrication might be neglected, one where heavy duty service is not a factor, or one requiring self-alignment . . . investigate the advantages of Ledaloyl Bearings and Parts. New uses are being discovered continually. In each application you can make substantial savings. Ledaloyl Bearings and Parts are extremely low in cost because they are produced by powder metallurgy, molded to shape, and require no machining. They are impregnated with oil and in service become self-lubricating. In many applications they give the utmost in service. Johnson Engineers will gladly help you determine whether you should use Ledaloyl bearings. Write for appointment.



SEND FOR DATA SHEETS GIVING PROPERTIES OF LEDALOYL

●

SLEEVE BEARING HEADQUARTERS SINCE 1901

JOHNSON BRONZE CO. 525 South Mill St., New Castle, Pa.

JOHNSON JB BEARINGS
Sleeve-Type

NEW PARTS AND MATERIALS

GALVANIC COATING 37

. . . applied cold by brush, spray or dip

Galvanite Corp., 40 W. 29th St., New York 1, N. Y.

Offering true cathodic protection, this coating combines with the base metal to set up electrical continuity.

Designation: Galvanite.

Form: Liquid containing 96% zinc by weight.

Size: ½-pint, 1-qt, 1 and 2 gal or quantity lots.

Service: Protection of ferrous metals for 600 hr against 20% salt spray at 95 F; protects against dilute acids, inorganic salt solutions, high humidity, sea and fresh water; temperatures to 350 F; fulfills copper-sulphate and adhesion-bond tests for hot-spelter galvanized steel; provides protection over previously rusted surfaces; coverage, 625 sq ft per gal: dries tack-free in 40 min; air-dries in 48 hr.

Properties: Cathodic cold galvanizing compound which deposits a film precipitate in the galvanic zone; iron salts formed are precipitated by zinc hydroxide as a clinging, protective form of rust.

For more data circle MD 37, Page 205

DRUM SWITCH 38

. . . for manual reversing of small motors

Square D. Co., 4041 N. Richards St., Milwaukee 12, Wis.

Indexing is smooth, positive and shockproof.

Designation: Class 2601, type A.

Size: 4¾ in. high, 2½ in. wide, 2⅞ in. deep, excluding handle.

Service: For across-the-line starting and reversing of squirrel-cage, single-phase ac motors designed for reversing, and series, shunt and compound dc motors;

Type	Volts	Horsepower Single-phase ac	Horsepower Polyphase ac	Horsepower Dc
AG-3*	115(110)	1	1	..
	230(220)	1	1	..
AG-1†	115(110)	1½	2	¼
	230(220)	2	2	¼
	440-550	..	1	..
AG-2†§	115(110)	1	1½	¼
	230(220)	1½	2	..
	440-550	..	2	..

* Breaks 2 lines. † Breaks 3 lines. § NEMA size 0.

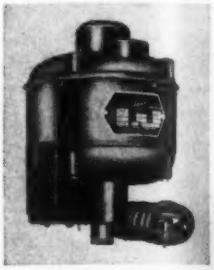
Design: Three copper movable-contact segments on main operating shaft are moved by handle to contact stationary copper contact fingers; starwheel and spring-loaded cam provide maintained-position operation, but can be converted to momentary contact without additional parts; NEMA general-purpose type 1 enclosure; two ½-in. conduit openings in bottom.

For more data circle MD 38, Page 205

VERTICAL MOTOR 39

. . . mounts directly on support columns

Hoover Co., Kingston-Conley Div., 68 Brook Ave., N. Plainfield, N. J.



Designed for sump pumps, this motor may also be applied to agitators, mixers and milk coolers.

Size: ⅓-hp.

Service: Output speed, 1725 rpm from 115 v, 60 cycle ac; cool-running; drip-proof.

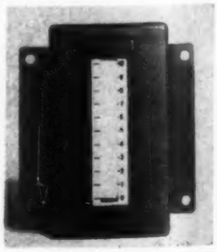
Design: Split-phase; heavy-duty ball thrust bearing; built-in float switch; automatic thermal protector; 8-ft rubber-covered cord and plug.

For more data circle MD 39, Page 205

MINIATURE INDICATORS 40

. . . show liquid level or valve position

Minneapolis-Honeywell Regulator Co., Industrial Div., 2954 Fourth Ave. S., Minneapolis 8, Minn.



Pneumatically operated, these indicators give the illusion of a liquid-level sight glass with a colored metal tape which moves vertically behind the indicating scale.

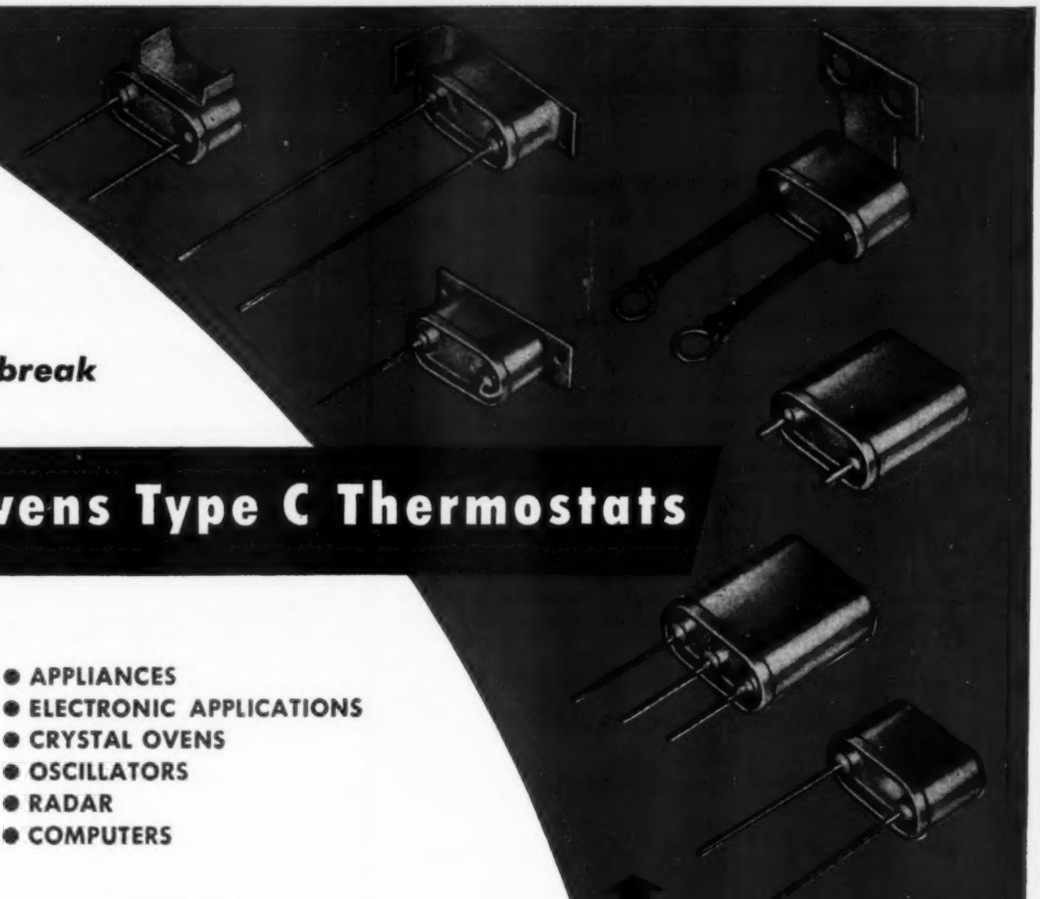
Size: 3½ in. wide, 6½ in. high, 15½ deep; panel cutout, 1⅝ x 5⅝ in.; scale length, valve-position unit —3¼ in., liquid-level indicator—3¾ in.

Service: Indicating liquid-level or valve position from 3 to 5 psi signal from pneumatic transmitting means; reproducibility, 1% full scale; error, less than 2% full scale; alarm signal is actuated at high or low level.

Design: Standard 3-15 psi pneumatic receiver actuates linkage with a force of ¼-lb per 1% full scale to position colored metal tape positively; direct or reverse action; scale divisions, 25% for valve-position, 2% for liquid-level indicator; alarm switches are placed so that actuation occurs automatically at high or low level, or may be adjusted throughout the full scale range.

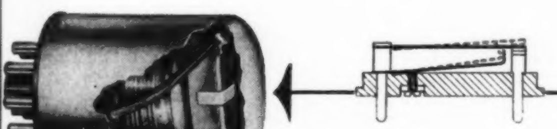
For more data circle MD 40, Page 205

for fast response
close control
clean make and break



specify Stevens Type C Thermostats

- APPLIANCES
- ELECTRONIC APPLICATIONS
- CRYSTAL OVENS
- OSCILLATORS
- RADAR
- COMPUTERS



HERMETICALLY SEALED

STANDARD

● Stevens Type C* thermostats, compactly designed for equipment requiring a high degree of temperature stability, feature an electrically independent bimetal that responds only to heat from controlled device. Contacts open only when bimetal overcomes spring pressure and friction of bimetal strip against contact spring surface—*for a clean, positive break.*

Supplied with virtually any type terminal in standard or hermetically sealed styles, Stevens Type C thermostats *open or close* the circuit upon any predetermined temperature rise from −75° to 600°F.

Get faster response, closer temperature control. Specify Stevens Type C thermostats in your product —*for better performance and longer life.* A-3967

*PATENT APPLIED FOR

STEVENS

manufacturing company, inc.

MANSFIELD, OHIO

Tiny Temp crystal oven courtesy of James Knights Co., Sandwich, Ill.

NEW PARTS AND MATERIALS

SILICONE RESIN 41

. . . has high-temperature bonding strength

General Electric Co., Chemical Div., Pittsfield, Mass.

Bonding strength and hardness is claimed to be retained at temperatures 50-90 C above any other known commercially available silicone resin.

Designation: SR-98.

Form: Light amber liquid with 50% solids content.

Service: As Class H insulation where vibration is a factor; can be used to treat glass cloth, asbestos paper or cloth and mica products; suitable for bonding and impregnating coils; when filled with inert material such as mica dust or talc to 25-50% by weight, resulting paste may be applied between coil insulation layers as heat-stable seal; can be thinned with xylene, toluene or petroleum spirits.

Properties: High bonding strength, hardness and low plastic flow; high abrasion resistance and film strength; requires no catalyst.

For more data circle MD 41, Page 205

METAL PRIMER 43

. . . dries for recoating in 3 minutes

Thompson & Co., Oakmont, Pa.

Drying completely within 10 min, this primer can be covered with lacquer without lifting or crazing.

Designation: SP-3523H.

Form: Liquid.

Size: 1 and 5 gal cans; 55 gal drums.

Service: Protecting ferrous metals with satin flat finish; test of 0.00075-in. thick film shows salt-spray resistance (ASTM) of 250 hr, humidity resistance (100% relative humidity at 100 F) of 500 hr, water-immersion resistance (room temperature) of 250 hr; can be used without finish coat to provide several months' protection; applied by spray, brush, flow coat or dip.

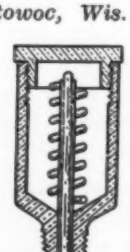
Properties: Iron oxide, zinc chromate primer; dries for recoating in 3 min, completely in 10 min.

For more data circle MD 43, Page 205

SMALL WICK OILER 42

. . . feeds filtered oil to bearing

Oil-Rite Corp., 2376 Waldo Blvd., Manitowoc, Wis.



Especially useful in dusty surroundings, these oilers are simple, sturdy and dustproof.

Designation: WOB.

Size: 1/8-in. pipe thread, 3/8-in. deep;

No.	Capacity (oz)	Cap (diam, in.)	Body (hex, in.)	Height (in.)
A-650-1	1/16	5/8	1 3/8	5/8
A-651-1	1/8	13/16	1 13/16	7/8
A-652-1	1/4	15/16	2 1/16	1
A-653-1	3/8	1 1/16	2 3/16	1 1/8

Service: Feeding filtered oil to bearings; oil of light or medium body must be used for proper capillary action; dustproof; wicks are easily removed and replaced.

Design: Wick-feed; oil is carried out of reservoir through wick over standpipe to bearing by capillary action plus siphon effect; one-piece hexagonal brass bodies and knurled brass screw tops machined from solid bar stock.

For more data circle MD 42, Page 205

SOLENOID VALVES 44

. . . have sliding metal-to-metal seal

Barksdale Valves, 1566 E. Slauson Ave., Los Angeles 11, Calif.

Tubular sealing members have a wiping action that removes foreign matter from the slide.

Designation: Shear-Seal.

Size and Service: Scoring, lodging of pipe scale or other foreign material is prevented by wiping action of seals; for air, hydraulic oil or water; low pressure drop; solenoids for 110, 220 or 440 v ac; pipe sizes, in., are available for different valve types and pressures as follows:

	250 psi	1500 psi*	3000 psi†
Shutoff	1/4, 3/8, 1/2, 3/4, 1	1/4, 3/8, 1/2	1/4, 3/8
2-way diverter	....	1/4, 3/8	1/4, 3/8
3-way selector	....	1/4, 3/8	1/4, 3/8
4-way selector	1/4, 3/8, 1/2	1/4, 3/8	1/4, 3/8
3-position, 4-way§	....	3/8	......

*1000 psi air. †1500 psi air. §Dual solenoid.

Design: Solenoid, normally open or closed; hardened and lapped tubular seals are forced against rectangular slide by line pressure, and provide sliding metal-to-metal seal; corrosion-resistant steel seals.

For more data circle MD 44, Page 205

ALLOY PRECISION Castings Company
EAST 45th ST. AND HAMILTON AVE. • CLEVELAND 14, OHIO

Important
pass this on

To Executives Charged with Responsibilities
of Design, Development and Production:

This is intended to call your attention to the Mercast frozen mercury process of investment casting — a development that manufacturers find helpful in solving difficult design and production problems. We suggest that you immediately investigate this versatile process which makes available one-piece shapes previously impossible to cast or machine.

Get this!

Frozen mercury patterns and our special ceramic investment material permit surface finishes and dimensional tolerances never before available in foundry production. For example, ±.002 to .003" per inch is consistently held. In many applications, our castings require no finish machining. Some mercastings, with intricate shapes and cavities, were previously fabricated parts which required expensive machining and assembly, or were too costly to make at all.

Big savings
here...
up to 78%?

ASTIC MOLD
CAVITY BLOCKS?

Our metallurgists can help you get mass production in such hard-to-machine metals as pure nickel, Hastalloy B, Rexalloy 108, stainless, Stellite, and others, both ferrous and nonferrous, at exceptionally close tolerances. Current applications — radar, aircraft, automotive, electrical, and machinery — indicate the wide, economical adaptability of mercasting. Here may be the answer to your problems involving design ... materials ... costs ... weight ... time ... machining capacity.

this hits
home

If this discussion suggests use of mercastings by your company, write to Dept. A-4 for Bulletin 706 — or tell us your specific problems. Our metallurgists and Mercast engineers will be glad to serve you.

rop a note today!
end those tough problems...

Sincerely,

Alloy Precision Castings Company

Alloy Precision Castings Company

ENGINEERING DEPARTMENT

EQUIPMENT

For additional information on this new equipment, see Page 205

TRACING TABLE 45

. . . of welded-steel construction

Stacor Equipment Co., 473 Troy Ave., Brooklyn 3, N. Y.

Finished in hard-baked hammertone gray, this table is available in two sizes of tracing surfaces.

Size: Tracing surfaces 20 x 25 in., 24 x 36 in.

Service: For general-purpose tracing; tracing surface angle is adjustable; fluorescent reflector designed to prevent eye strain.

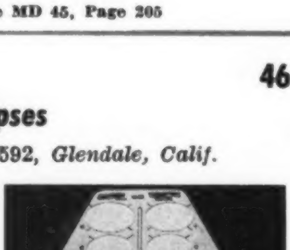
Design: Welded-steel frame; fluorescent reflector with smooth glass working surface and sand-blasted underside for diffused lighting; 20 x 25-in. surface furnished with two 20-watt fluorescent lamps, 24 x 36-in. surface with two 30-watt lamps; two adjusting arms raise and lower tracing surface.

For more data circle MD 45, Page 205

PLASTIC TEMPLATE 46

. . . for isometric ellipses

Rapidesign Inc., P. O. Box 592, Glendale, Calif.



Slot arrangement permits all three axes in one elevation to be drawn without turning template.

Designation: 123

Size: 11 in. wide, approximately 6⅜ in. high, 0.040-in. thick.

Service: For isometric drafting; 38 ellipses, in 1/32-in. increments from ⅛-in. to 1-in., in 1/16-in. increments from 1-in. to 1 9/16-in.; pencil allowance for accuracy.

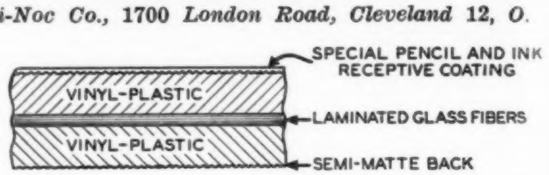
Design: Ellipses grouped around three slots which form isometric axes; with base of template on straight edge, ellipses line up with vertical axis; laid on left edge, ellipses line up with left-hand elevation; laid on right edge, ellipses line up with right-hand elevation; printed ellipse dimensions referred to axis center lines; cutouts are machine milled; plastic.

For more data circle MD 46, Page 205

PLASTIC SHEETS 47

. . . for drafting and lofting

Di-Noc Co., 1700 London Road, Cleveland 12, O.



These translucent clear vinyl sheets have pencil and ink receptive coating on work side.

Designation: Dinoglass

Size: 0.010-in. thick sheets in sizes from 8½ x 11 in. to 50 x 108 in.

Service: Full-scale drafting and aircraft lofting; sheets are dimensionally stable, thermal coefficient of expansion is 0.0000247 in. per in. per deg F.

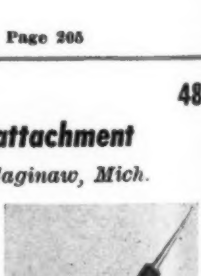
Design: Vinyl sheets press laminated with glass fibers; press-planished semimatte finish one side, pencil and ink receptive coating other side.

For more data circle MD 47, Page 205

DIAL INDICATOR 48

. . . features built-in hole attachment

Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.



One-piece construction of base and shank provides lightweight rigid mounting for indicating mechanism.

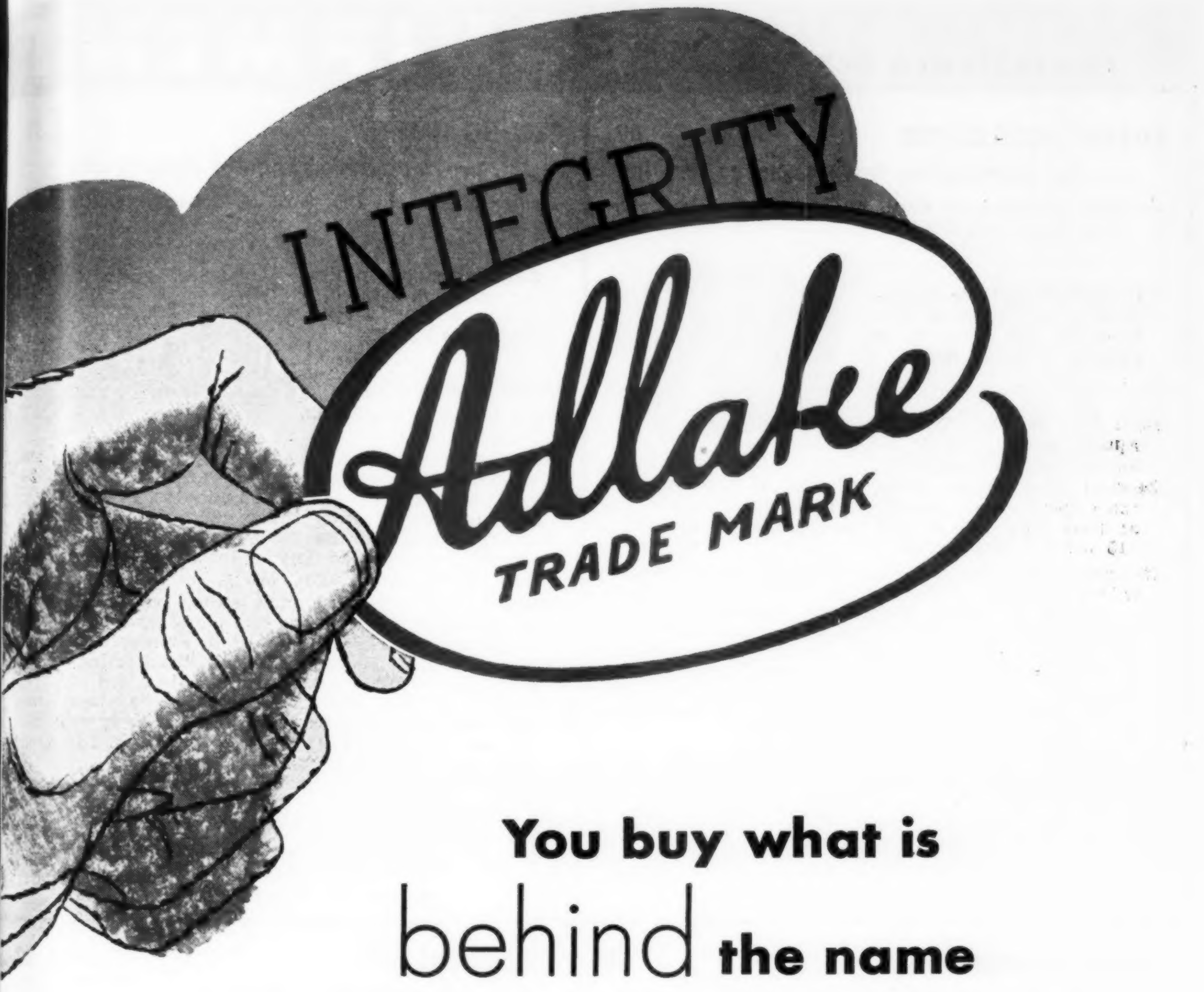
Designation: 399A

Size: 1½-in. diameter dial; approximately 5½-in. overall length with hole attachment in place.

Service: Indicator range, 0.200-in. (two revolutions of dial hand); hole attachment range, 0.125-in.; dial reads clockwise from 0 to 50 to 0; scale divisions, 0.001-in; zero position of dial adjustable.

Design: Indicating mechanism mounted on bar which forms base and shank of indicator; jeweled thrust bearing; movable outside knurled bezel ring contains dial; bezel clamp is provided for tension adjustment; hole attachment screws directly to base; contact point extends out of back of case and is perpendicular to dial.

For more data circle MD 48, Page 205



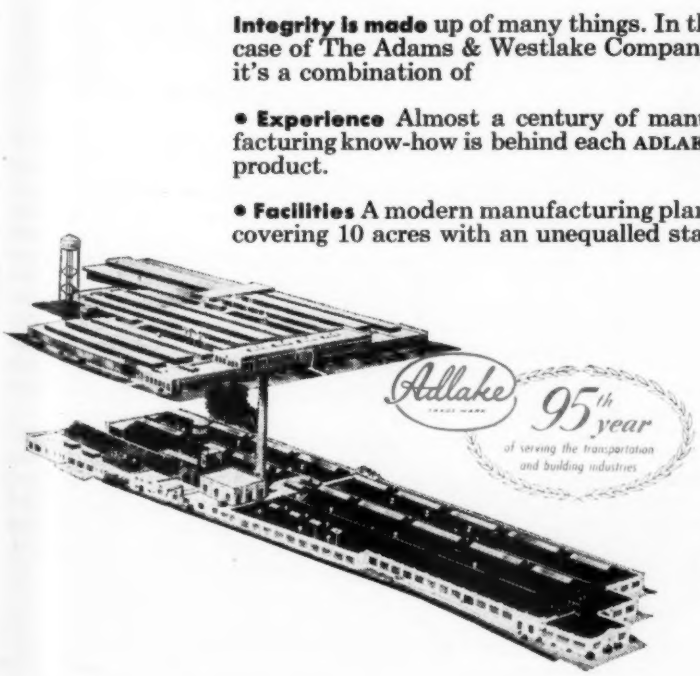
You buy what is behind the name

When you buy an ADLAKE product, you receive something with it that never shows up on an invoice . . . the integrity of the manufacturer.

Integrity is made up of many things. In the case of The Adams & Westlake Company, it's a combination of

- **Experience** Almost a century of manufacturing know-how is behind each ADLAKE product.
- **Facilities** A modern manufacturing plant covering 10 acres with an unequalled staff of specialists to maintain the high level of ADLAKE workmanship.
- **Good Faith** ADLAKE's policy has always been to keep faith with its customers. For that reason, no effort is spared to make sure that every purchaser gets precisely what he bargained for and that he is always satisfied.

This integrity is an integral part of every ADLAKE Mercury Relay . . . as thousands of dependable, economical installations in an amazing variety of industries will testify!



THE
Adams & Westlake
COMPANY

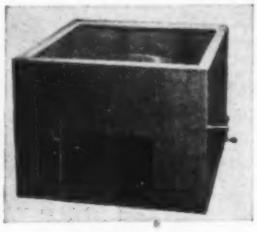
Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of
Hermetically Sealed ADLAKE Relays

ROTARY ACCELERATOR 49

. . . for acceleration testing and calibrating

Statham Development Corp., 12411 *W. Olympic Blvd., Los Angeles* 64, *Calif.*



Controlled variable centrifugal acceleration is provided in this device by a rotating circular table.

Size: 16⅞ in. high, 23¼ in. square; weight, 120 lb; 16-in. diameter rotating table.

Service: Acceleration range, 0.1-100g at 5-in. radius; table speed range, 0-1000 rpm; load limitations, 1 lb at 1000 rpm, 5 lb at 200 rpm; power requirement, 115 or 220 v, single-phase, 60-cycle.

Design: Table drive is ⅛-hp, 3600-rpm electric motor with variable-speed Graham transmission; table speed controlled by crank coupled to transmission; approximate table speed indicated by rpm dial, four stroboscopic disks are provided for precise measurement; power and signal leads connected to control panel on front of case; solid coin-silver slip rings and silver graphite brushes; Dural table; plywood case with safety-glass cover for observation.

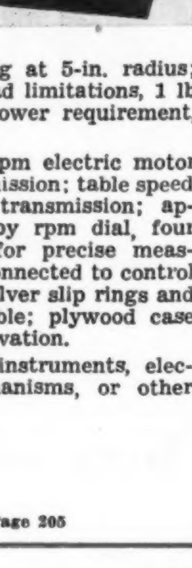
Application: Calibrating or testing instruments, electronic subassemblies, small mechanisms, or other similar equipment.

For more data circle MD 49, Page 205

HAND TACHOMETERS 50

. . . have improved indicating mechanism

O. Zernickow Co., 15 *Park Row, New York* 7, *N. Y.*



Speed-indicating hand makes almost two complete revolutions for each of the three range settings.

Designation: 33, 44 O-Z Universal

Size: 3-in. dial; overall length, 5½ in.; carrying case, 6⅝ x 4¼ x 3 in.; tachometer weight, 18 oz; with case and accessories, 30 oz.

Service: For measuring rpm or fpm speeds; accuracy of 0.5% at any reading; reads in either direction of rotation; unaffected by changes in temperature, electricity, magnetism and moisture or by rapid acceleration and normal overspeeding; operates in any position; triple-selective speed range:

Type	Ranges (rpm)		
33	25-300	250-3000	2500-30,000
44	30-400	300-4000	3000-40,000

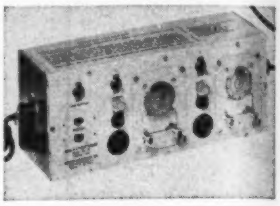
Design: Centrifugal-governor type with new patented cross pendulum; inside scale of dial is read with first revolution of indicator, outside scale with second revolution; wind-vane type damping mechanism; ranges spring-locked in position, shifted by rotating knurled cap; ball and jewel bearings; aluminum-alloy housing; furnished with case, wheel, extra tips.

For more data circle MD 50, Page 205

CYCLING TIMER 51

. . . provides wide range of time cycles

Becker Equipment Co., 3020 *N. Cicero Ave., Chicago* 41, *Ill.*



Adjustable plug-in timing units can be used to obtain widely varying time-cycle limits.

Designation: Add-A-Cycle

Size: 13¾ in. wide, 5½ in. high, 5 in. deep.

Service: For component testing or process timing; six adjustable timing unit ranges—1.5-12 seconds, 3-24 seconds, 15-120 seconds, 1.5-12 minutes, 4-30 minutes, 15-120 minutes; each timer can take two timing units; timers can be cabled together and group-operated to provide any number of time cycles; normal rating, 10 amp, 115 v, 60 cycles.

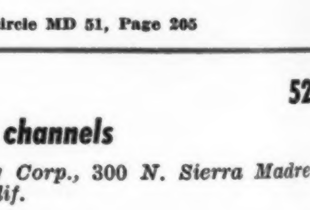
Design: Plug-in timing units reduce set-up time to minimum; each timer has two plug-in positions with individual switches; any plug-in timing unit in a sequence may be skipped without affecting other units; operating instructions printed on top of case; special ratings available; process timers are custom built with wall-mounting case and any required number of adjustable plug-in units; finished in gray hammered lacquer.

For more data circle MD 51, Page 205

BRIDGE BALANCE 52

. . . has eight data channels

Consolidated Engineering Corp., 300 *N. Sierra Madre Villa, Pasadena* 8, *Calif.*



This instrument acts as measuring unit and control center between recording oscillograph and electrical data sources.

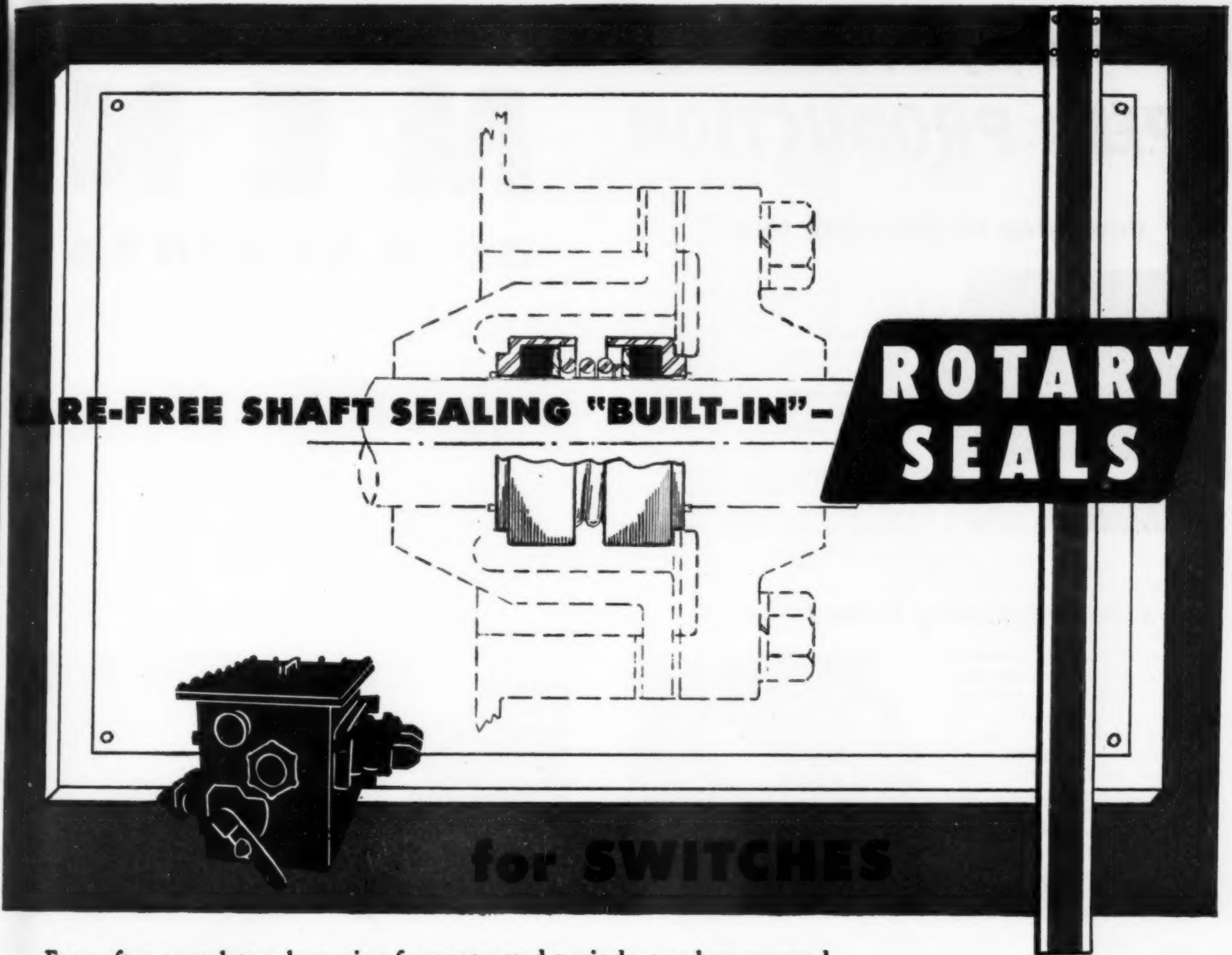
Designation: 8-108

Size: 16¼ in. long, 7 in. high, 7 in. deep; weight, 21 lb.

Service: For direct recording of output of four-arm strain-gage bridges or resistive-type pickups without amplifiers; takes up to 8 pickups of 120 to 350 ohm resistance; individual bridge voltage adjustment from level of supply voltage, 28.5 v dc max, to min of 2.0 v on 350 ohm bridge and 1.1 v on 120 ohm bridge; may be used with pickups of less than four active arms if dummy external gages are added; output stable ±2 per cent of full scale within ambient limits of −20 to 60 C, 0 to 95 per cent relative humidity, 0 to 0.060-in. double amplitude vibration (up to 60 cps).

Design: Battery-operated circuits; built-in 30 v full-scale voltmeter and 50-0-50 microampere balance meter connect to any channel by selector switches; inadvertent changes in balance of channel prevented by automatic-locking control; polarity of each channel reversed by switch on front panel; plug-in connectors; grey, wrinkle finished cabinet.

For more data circle MD 52, Page 205



Even after complete submersion for protracted periods, or when exposed to weather extremes, heavy duty Switches must be in perfect condition to make an alternate source of power immediately available the instant cable trouble occurs. Any Seal failure at the point where the operating shaft extends through the wall of the hermetically sealed tank might be serious. To assure the *Shaft-Sealing Certainty* they must have, ROTARY SEALS have been the choice of leading Switch-makers for many years.

Special adaptations of the time-tested ROTARY SEAL principle have been made to fit exactly the requirements of many different types and models of Switches—to give top efficiency in conjunction with other elements in the Switch design. Similarly, "tailor-made" applications have been worked out by our Shaft-Sealing specialists for equipment in many diverse fields, wherever *Certainty in Shaft Sealing* and care-free operation are essential for continuous satisfactory performance.

The experience of our engineers in adapting the ROTARY SEAL principle to the particular requirements of manufacturers in many fields is at your service to determine the best method of assuring *Shaft-Sealing Certainty* for your application. It is usually best to call us in at the drawing-board stage—we can often point out simpler and more practical ways to approach the Shaft-Sealing problem.

THE ROTARY SEAL PRINCIPLE

is the original approach to a practical solution of a universally troublesome problem. Our booklet "SEALING WITH CERTAINTY" explains and illustrates the principle. We're glad to send it to you without obligation.

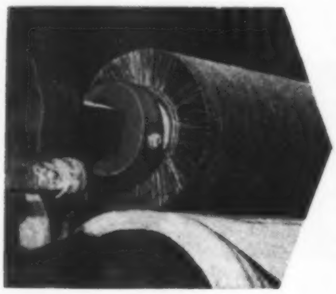
THE ROTARY SEAL COMPANY

mechanical seals for rotating shafts

2022 NORTH LARRABEE STREET
CHICAGO 14, ILLINOIS, U.S.A.

How Pittsburgh Brushes SPEED PRODUCTION

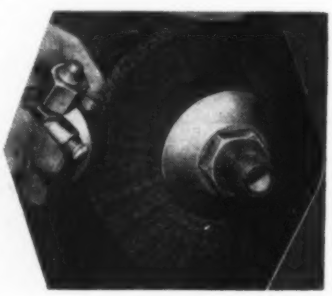
1. Removing oil film from steel!



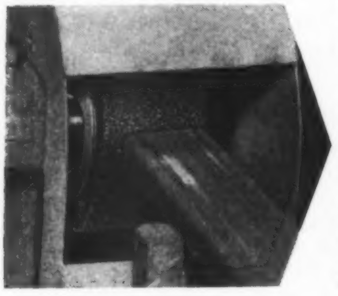
Crown Cork & Seal Co., Inc., asked Pittsburgh engineers to recommend a brush suitable for washing oil film from steel before annealing. A "built-up" brush made of Tampico sections was installed. Oil and foreign matter were completely removed without harming the surface of the steel. Production showed an immediate increase, and time saved due to fewer brush replacements added to the overall savings.

2. Satin-finishing brass fixtures!

Frequent breakdowns and brush changes hampered Bastian-Blessing Company's production of satin-finish parts for its products. Pittsburgh engineers recommended a crimped steel, standard 10" brush. Reports after three years' use show Pittsburgh Brushes have increased production, improved quality and saved materials . . . while lasting *three times longer* than previous brushes!



3. Removing burrs from steel!



Problem: The National Electric Company needed a brush to eliminate burrs and scale, yet the brush had to combine cleaning ability with long life. Solution: Pittsburgh designed a brush to specifications—a brush that was stiff and tough enough to penetrate, clean, and remove burrs and scale, and rugged enough to stand up. Result: An increase in efficiency; a jump in production!

Let Pittsburgh Engineers Solve Your Brush Problems. Pittsburgh's complete line of brushes of every type, for every purpose, will provide a practical and economical solution of any brush problem you might have. Drop us a line on your company letterhead for a copy of our new booklet that shows, through actual case histories, how Pittsburgh brushes help cut your operating costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-1, 3221 Frederick Ave., Baltimore 29, Md.

PITTSBURGH *Power Driven* BRUSHES

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

MEN OF MACHINES

John W. Greve

F. S. Blackall Jr.

John W. Greve has been named editor of *The Tool Engineer*, official publication of the American Society of Tool Engineers. He will be located at ASTE headquarters in Detroit. Mr. Greve has been a member of the editorial staff of MACHINE DESIGN since 1939. For ten years prior to that time he was associated with Westinghouse Electric Corp. in the capacity of technical writer and editor. He received his B.S. degree in industrial engineering from Carnegie Institute of Technology in 1929. Mr. Greve is a registered professional engineer in the state of Ohio, a member of the Society for Experimental Stress Analysis, an associate member of the Society of Business Magazine Editors and a life member of the Cleveland Engineering Society, which he has served as president and also as chairman of the Machine Design Division.

•

Recently announced was the nomination of **Frederick S. Blackall Jr.**, president and treasurer of the Taft-Pierce Mfg. Co., Woonsocket, R. I., as president of the American Society of Mechanical Engineers for 1953. His term of office will begin at the conclusion

of the ASME annual meeting in December. Mr. Blackall joined the Taft-Pierce Mfg. Co. in 1922. He became vice president and general manager in 1929 and has been president and treasurer since 1933. A member of a four-man committee which went to London in 1946, Mr. Blackall helped resolve the American and British differences in screw threads. His contribution to the development of the Unified Thread System, since adopted as standard by the United States and Great Britain, is regarded as of wide importance. Mr. Blackall is a Fellow of the ASME and a member of the American Society of Metals, American Society of Tool Engineers, Providence Engineering Society, American Ordnance Association, Newcomen Society, Sigma Alpha Epsilon and Theta Tau.

♦

Ralph M. Watson

Worthington Corp., Harrison, N. J., recently named **Ralph M. Watson** as director of research. He succeeds **Paul Diserens,** who, although he has retired, will continue to serve the company in a technical consulting capacity in engineering and research. Mr. Watson received his B.S. degree in mechanical engineering from the California Institute of Technology in 1927 and one year later was awarded a Master's degree from the same Institute. During the next nine years he served as engineer in municipal water works in California and as a graduate assistant in the California Institute of Technology. Mr. Watson joined the Worthington organization in 1936 as an engineer in the refinery pumps section of the Centrifugal Pump Div. in Harrison. In 1942 he was made chief engineer of that division and three years later was named assistant to the vice president in charge of engineering. He is a member of Tau Beta Pi and the American Society of Mechanical Engineers.

♦

John D. Judge has been appointed president of Tube Reducing Corp., Wallington, N. J., to succeed the late **J. J. White.**

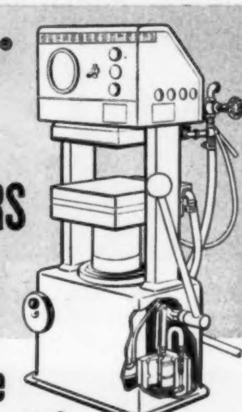
♦

The Hoover Co., North Canton, O., has instituted an experimental plan to carry out its research and development programs. According to **Dr. G. Pierce Daiger,** assistant vice president of engineering, a new unit, to be called the applied research group, has been organized and will be given broad creative assignments in the electric appliance field. Three engineers have been appointed to the new group: **Jack**

TEST RESULTS . . . .

PALMETTO® G-T RING

CHOSEN BY MAKERS OF PRECO PRESS



Gives best performance of all packings tested

Preco Incorporated of Los Angeles, Calif., makers of the 20 ton hand operated Preco Hydraulic presses, needed a reliable packing . . . a packing which would hold 3200 psi at 140 F. Packing rings were to be installed in grooves cut in cast iron pistons operating at low speeds in honed mild steel cylinders . . . a lightweight motor oil to be used for hydraulic fluid.

Make Their Decision

C. L. Rector, Test Engineer, and Paul Anderson, Product Engineer, ran exhaustive trials on many packings . . . checked results—and made their decision: Palmetto G-T Ring!

Why the Palmetto G-T Ring

The Palmetto G-T Ring's ability to seal without extrusion is outstanding. Performance without extrusion has been obtained with pressures as high as *50,000 psi.*

Its principle of operation is unusually simple:

HOW PALMETTO G-T RINGS WORK . . .

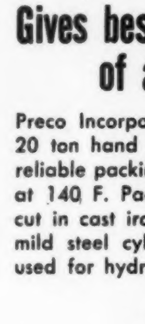


Fig. 1 shows Palmetto G-T Rings with no pressure applied. CLEARANCES between the FLANGES of the RESILIENT SECTION and the laminated plastic NON-EXTRUSION RINGS, as well as between rings and CYLINDER WALL prevent low pressure friction.

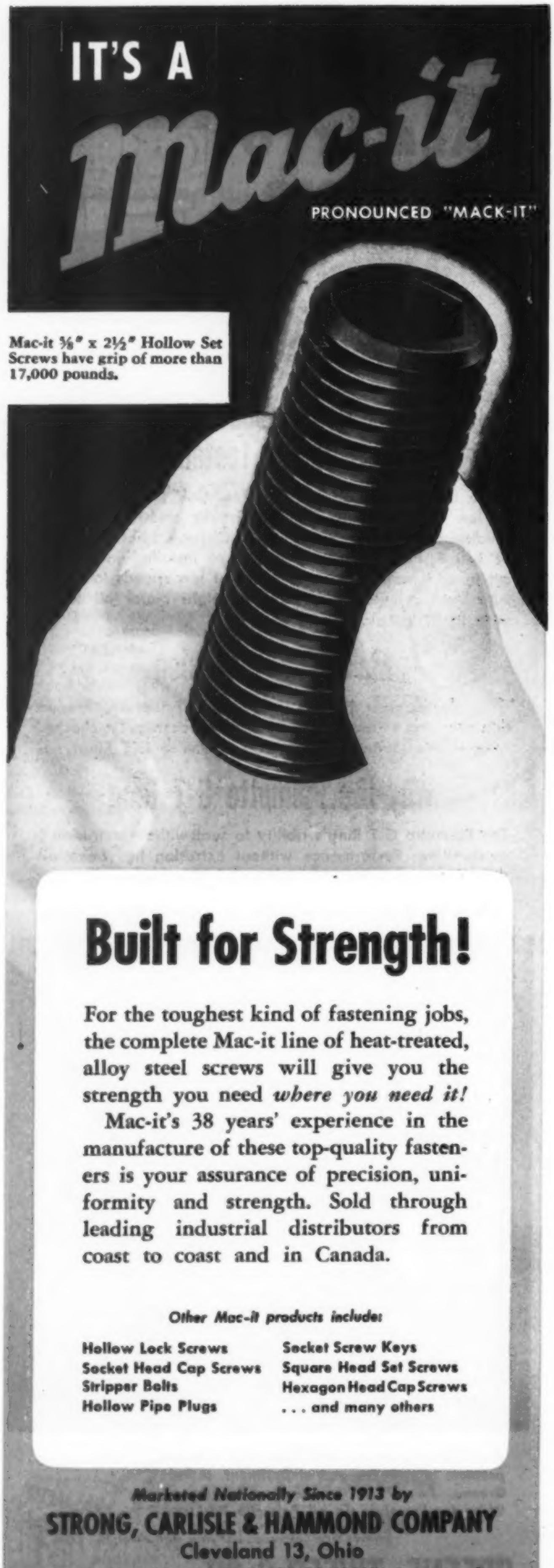
Fig. 2 indicates now the RESILIENT SECTION flows under pressure, causing the FLANGE to swell under the rings on the low pressure side, bringing them to bear on the CYLINDER WALL. CLEARANCE spaces are closed, preventing any extrusion of the packing material. The piston, forced to a central position, will move forward without binding or jamming and with no damage to packing or CYLINDER WALL. Elimination of extrusion of the packing material is the outstanding feature that makes Palmetto G-T Ring Packing the ultimate in seals.

If a superior packing can solve a knotty design problem in your research department, contact Greene, Tweed for cooperative assistance. Write for literature on all Palmetto Packings.

PALMETTO Packings

packing more performance into every application

GREENE, TWEED & CO. NORTH WALES, PA.



Men of Machines

E. Duff, formerly section head in the electrical laboratory; **Melvin H. Ripple,** a designer in the development group; and **John E. Vance,** formerly staff designer in the development group.

•

George S. Cherniak has been named vice president of engineering for Control Engineering Corp., Canton, Mass. He will be responsible for the corporation's engineering operations, including the development of new products, and applications of existing products and facilities to new problems. Mr. Cherniak was formerly executive engineer for Anderson-Nichols & Co.

•

Formerly manager of engineering, **Harold A. Strickland** has been named vice president and manager of engineering for Hotpoint Co., Chicago.

•

Boris Osojnak, who had been engineering supervisor of the research and development department of Heyl & Patterson Inc., Pittsburgh, recently joined Paxton Engineering Co. of Los Angeles as project engineer. The Paxton company is an affiliate of McCulloch Motors Corp. engaged primarily in development and research for the parent organization.

•

To supervise the company's entire engineering department, **Richard T. Johnstone** has been appointed chief draftsman of Snyder Tool & Engineering Co., Detroit. Mr. Johnstone joined the company's control engineering department in 1950, designing electrical and hydraulic systems.

•

Ambrose C. Miller recently joined The William Brand & Co. Inc., Willimantic, Conn., as product engineer. Mr. Miller comes to his new position from the Philco Corp. in Philadelphia, with whom he has been associated since 1927.

•

The promotion of **C. J. Breitwieser** to director of engineering has been announced by P. R. Mallory & Co. Inc., Indianapolis. Previously executive assistant to the vice president in charge of engineering, he now assumes direct responsibility for the company's central research laboratories and general engineering staff, as well as functional direction of divisional engineering departments. Dr. Breitwieser came to Mallory in June 1951 from Consolidated Vultee Aircraft Corp., where he served as chief of electronics and head of the engineering laboratories.

•

S. C. Leyland has been named manager of engineering for the Westinghouse Electric Corp. Meter Div. He will be responsible for the design of all of the division's products, including watthour meters, relays, instruments and auxiliary equipment. Mr. Leyland joined Westinghouse at East Pittsburgh in 1925 and held various engineering posts there until he was transferred in 1931 to the Meter Div. as design en-

you'll consider

MAGNESIUM

In almost any product where motion is involved, light weight is a primary requisite. From airplanes to portable saws, magnesium, the lightest of all structural metals, pays off handsomely by allowing the addition of extra features *without increasing weight!* But that's only half of the potent sales story magnesium has to tell. Of equal importance is its remarkably high strength/weight ratio. This advantage can be translated into profits by greatly simplified constructions resulting in lower production costs. To the designer, magnesium offers unprecedented flexibility with a variety of alloys possessing characteristics of strength, toughness, machinability and corrosion resistance. Fabricated magnesium is produced in all common forms: castings, forgings, extrusions, sheet and plate; and can be economically worked by all standard shop practices.

That is why we say, "If you design with light weight in mind, you will naturally consider the metal of motion . . . MAGNESIUM."

THE DOW CHEMICAL COMPANY
Magnesium Department • Midland, Michigan

A new multiple leaf spring holds the collar in place—enables this Lovejoy Coupling to withstand considerably higher speeds with complete safety. Free-floating load cushions suspended between heavy metal jaws—no metal-to-metal power transmission. Instant adjustment for shock, vibration, surge, backlash and misalignment. No lubrication needed. Cushions available for every duty . . . 1/6 to 2500 h.p.

WRITE TODAY FOR COMPLETE CATALOG AND QUICK-FINDING SELECTOR CHARTS

LOVEJOY FLEXIBLE COUPLING CO.

5018 W. Lake Street Chicago 44, Illinois

Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

Men of Machines

gineer for indicating instruments. From 1941 until his new appointment he served as manager of the relay engineering section. Succeeding Mr. Leyland as manager of the Meter Div. is **William K. Sonnemann**, who has served as a relay design engineer for the division since 1936.

♦

Vard Inc., Pasadena, Calif., recently appointed **M. D. Parmiter** to the position of chief engineer and **Richard E. Shafer** to chief production engineer.

♦

W. S. Shamban & Co., Los Angeles, has appointed **Henry A. Traub** as chief engineer and **Frank R. Chaffin** as research director. Mr. Traub, who was formerly associated with Douglas Aircraft Co. Inc. in Santa Monica, Calif., will direct engineering activities. Mr. Chaffin, former assistant director of research of Specialized Instruments Corp., Belmont, Calif., will head fluorocarbon product research and development.

♦

Joseph W. Jensen has been named chief engineer of the Cedar Rapids Div. of Cherry-Burrell Corp., Chicago. He will be responsible for the design, development and inspection of all equipment produced by the division. Mr. Jensen had been associated with the J. I. Case Co. as a mechanical engineer.

♦

Minnesota Mining & Mfg. Co., St. Paul, has appointed **Donald R. Guthrie** as executive engineer in charge of engineering research. Mr. Guthrie will organize an engineering research group consisting of three sections: chemical engineering, machine development and instrument engineering. The purpose of the new group will be to provide specialized engineering assistance to engineers in the company's various product divisions.

♦

Robert S. Caruthers has joined the Lenkurt Electric Co., San Carlos, Calif., as chief systems engineer. For 23 years prior to his new assignment, Mr. Caruthers had been associated with the Bell Telephone Laboratories.

♦

A machine designer for Acme Engineering Co., Chicago, **Karl H. Nelson** has been appointed an associate design engineer in the mechanism and propulsion department at Armour Research Foundation of Illinois Institute of Technology.

♦

Frederick G. Suffield was recently appointed engineering manager for Transco Products Inc., with headquarters at the company's Los Angeles plant.

♦

Melpar Inc., Alexandria, Va., a subsidiary of Westinghouse Air Brake Co., has announced that **Ralph I. Cole** and **Vernon C. Weihe** have joined its engineering staff. Mr. Cole was formerly technical director of the Rome Air Development Center, and Mr. Weihe was systems engineer for the Air Transport Association.

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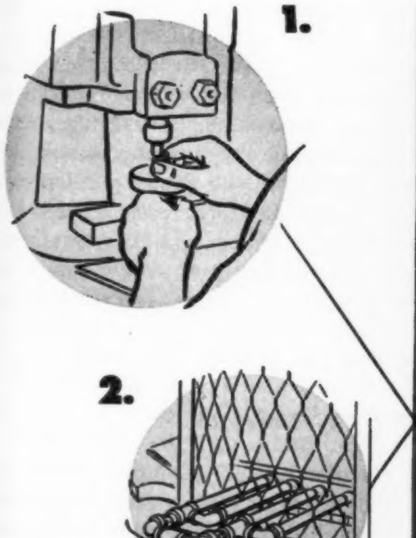

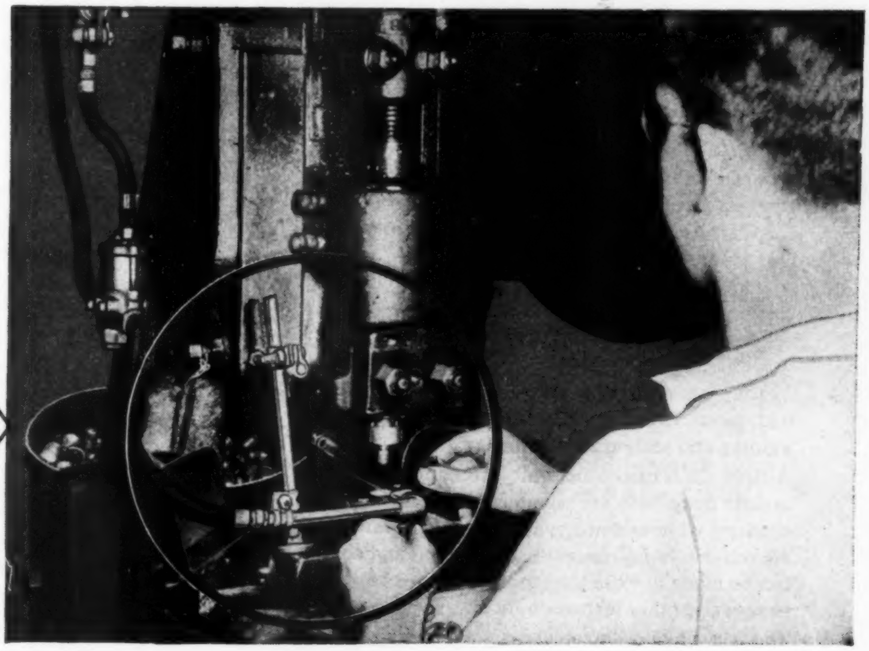

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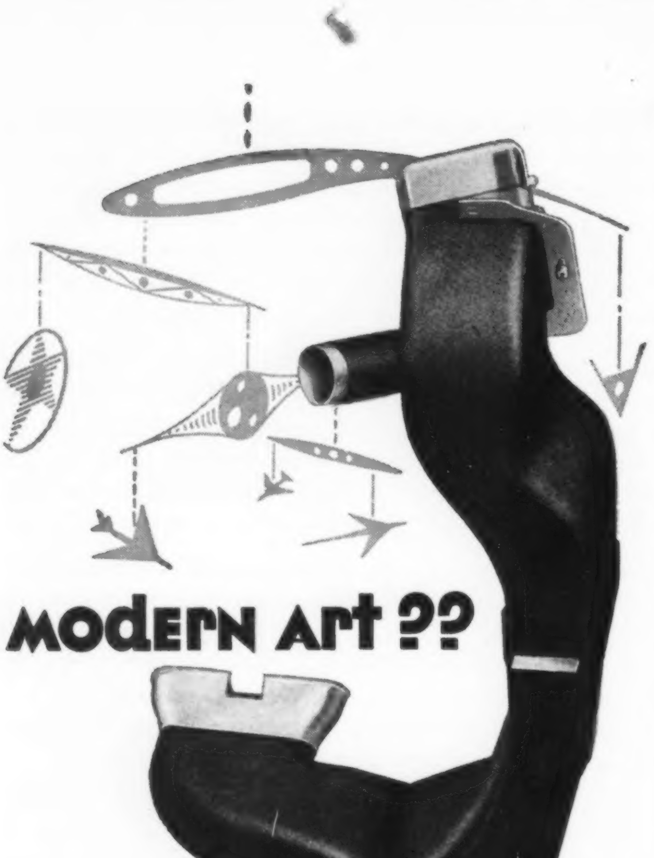

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the art of fabricating Fiberglass ducts in shapes too complex for conventional materials. Arrowhead Rubber Company's custom-built Airtron ducting, made of flexible rubber impregnated Fiberglass, offers many advantages over metal. Ducts designed to individual customer specification can be made to practically any conceivable shape in experimental or production quantities at cost savings frequently as much as 45%. Tooling costs are reduced to a fraction—as compared with metal. Costly metal forming, riveting, welding and sealing are eliminated.

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The Airtron duct shown above solved a cramped space problem encountered in the design of a heavy bomber. It's typical of countless unusual ducting problems which Arrowhead engineers specialize in solving.

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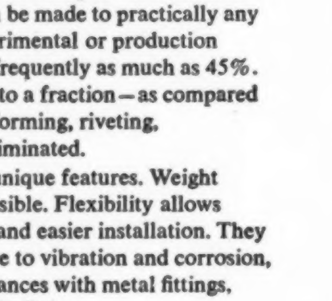

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THE ENGINEER'S Library

The Welding of Non-Ferrous Metals

By E. G. West, technical director, Aluminum Development Association (Great Britain); published by John Wiley & Sons Inc., New York; 565 pages, 5½ by 8½ inches, clothbound; available from MACHINE DESIGN, *$8.50 postpaid.*

Written for the welder and student as well as the designer and metallurgist, this book provides basic information on the application of the various welding processes to nonferrous metals. The "how to" approach is used throughout in presenting the material; however, brief explanations on the metallurgical, physical, and chemical phenomena encountered in welding have also been included wherever necessary for understanding.

The first five chapters are introductory and deal briefly with weldability, properties important in welding, fusion welding processes, resistance welding processes and pressure welding. In the remaining ten chapters, which constitute the main portion of the text, the welding of various nonferrous metals is covered. Materials treated are: aluminum, magnesium, copper, nickel, lead, zinc, and their alloys; low melting point metals; high melting point metals; and precious metals.

Association Publications

Elements of Hardenability: Complex in its mechanism and often defying precise analysis, hardenability has been the subject of extensive investigation and experiment. In this book the quantitative aspects of hardenability of steel and its underlying principles, where discernible, are discussed. The introductory chapter takes up the various types of hardenability tests and is followed by a chapter on the nature of hardening. Chapter 3 deals with the nature of the quenching process and the concluding chapter covers the effects of alloying elements on hardenability. Clothbound in 6 by 9-in. size, the book by M. A. Grossmann contains 170 pages. Copies are available for $4.50 each from the American Society for Metals, 7301 Euclid Ave., Cleveland 3, O.

How to Improve Engineering-Management Communications: This report is a summary of the first of a series of Executive Research Surveys sponsored by the National Society of Professional Engineers through its Professional Engineers Conference Board for Industry. More than 350 representative com-

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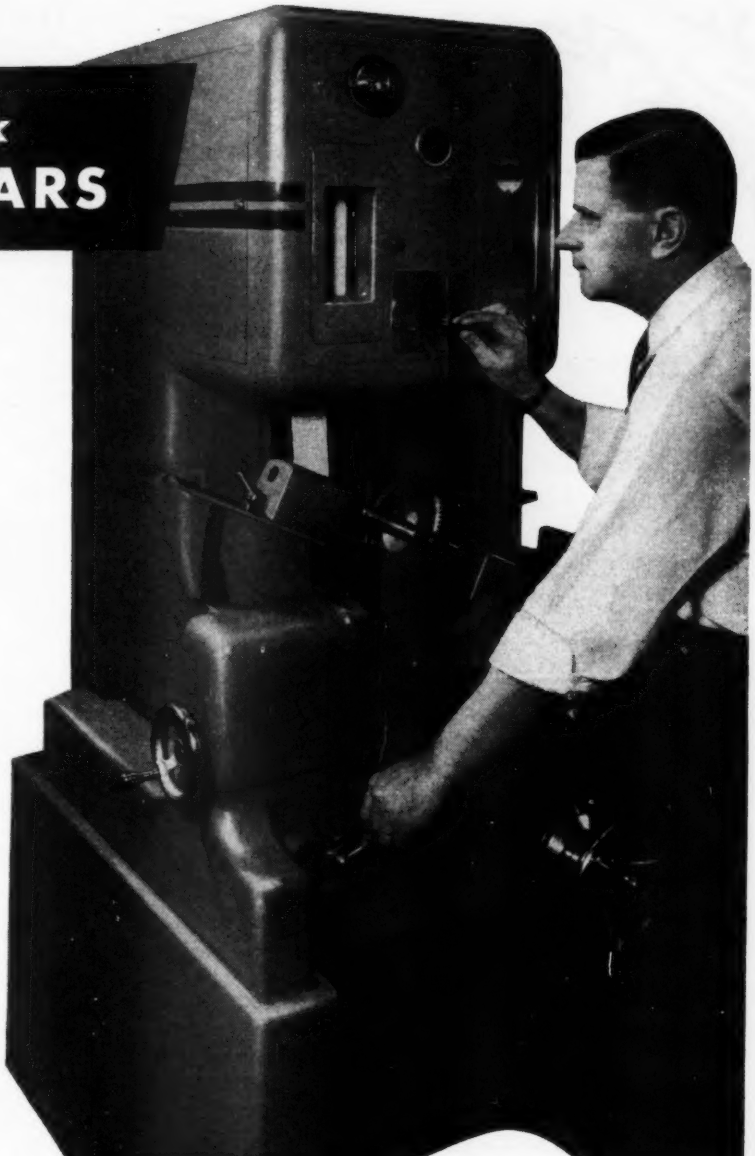

Kodak Conju-Gage Gear Checker, Model 8U, tests gears up to 8½ inches in pitch diameter. Smaller models check gears up to 1¼ and 4⅛ inches, respectively.

To gear manufacturers and engineers faced with the problem of quantity production of tight-tolerance gears, a Kodak Conju-Gage Gear Checker provides the ideal solution.

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To find out more, send for your copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." It's free, without obligation. Write to Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

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No joke intended! This Cambridge Woven Wire Conveyor Belt carries cleaned fish through a wash tank to remove scales and scrap so the fish will present an attractive appearance on retail counters.

Cleaned fish are dropped from cleaning table A, onto the surface of conveyor belt B, passing through wash tank C. At the end of the tank hold down angles change the movement of the belt to a 60° incline. Stainless steel wire, used in weaving this belt, resists the corrosive attack of salt water in the wash tank, can be cleaned without damage by steam or by detergents added to the wash water.

In this application, BALANCED BELTING provides low original cost and controllable belt travel. ½" openings in belt weave permit free drainage of wash water and fish scraps. Angle cleats across the belt hold the fish during the movement up the incline.

This is a typical example of the many types of production and processing problems solved by the use of Cambridge Woven Wire Conveyor Belts. Cambridge belts can be constructed from any metal or alloy to a wide range of meshes and weaves. Don't fish around the next time you have a problem of combining movement with processing through heat, cold, liquids or corrosive agents . . . just call in your Cambridge field engineer for his experienced advice. Write direct or look under "Belting-Mechanical" in your classified telephone directory.

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The Engineer's Library

panies were polled on the subject of engineering-management communications methods by questionnaires, personal inquiries and consultations. The first five chapters of the report are devoted to the results of the survey and their interpretation. The concluding chapter presents a brief summary of the results and offers recommendations on how to improve communications based on the survey findings. Paperbound, 6 by 9 inches in size, and containing 46 pages, copies of the report are available for $2.00 each from the National Society of Professional Engineers, 1121 Fifteenth St., N.W., Washington 5, D. C.

Proceedings of the Fifteenth Annual National Time and Motion Study and Management Clinic: Completely transcribed in this 128-page booklet are the talks, papers and discussions presented before the 1951 clinic of the Industrial Management Society in Chicago, Ill. Topics covered include: time study, motion economy, methods, plant layout, materials handling, wage incentives, maintenance, and human relations. Participating in the clinic as contributors were representatives of labor, management and government. Paper-bound in 8½ by 11 inch size, copies of the booklet are available for $4.00 each from the Industrial Management Society, 35 E. Wacker Drive, Chicago 1, Ill.

Manufacturer's Publication

A Compilation of Analog Transducers—by Mark T. Nadir: In order to utilize the cathode-ray oscillograph for nonelectrical research, an appropriate transducer must be used to convert the effects to be measured into equivalent electrical signals. In this compilation, over 500 types of analog transducers are listed alphabetically by function. For each model of transducer, the manufacturer and mechanical and electrical characteristics are provided. In addition, a transducer accessory listing and a tabulation of Geiger-Mueller tubes for radiation study are included. Containing 68 pages, this manual is paper-bound and 8½ by 11 inches in size. Copies are available for 50 cents each from Allen B. DuMont Laboratories Inc., Instrument Div., 1500 Main Ave., Clifton, N. J.

Government Publications

NACA Technical Series: Each of these reports is 8 by 10½ inches in size, paper bound and side-stapled and contains complete drawings and illustrations. The following Technical Notes are available:

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Copies of these reports may be obtained from the National Advisory Committee for Aeronautics, 1924 F St., NW, Washington 25, D. C.

New Standards

Acme Screw Threads—ASA B.1.5-1952: General purpose and centralizing threads are the subject of this revision of an American War Standard (AWS B1.5-1945). Two appendixes and 26 tables are included in the 41-page standard. Copies are available from the American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., for $2.25 each.

Stub Acme Screw Threads—ASA B1.8-1952: Based on the generally restricted use of stub acme threads to applications where a coarse-pitch thread of shallow depth is required, this new standard covers: specifications, preferred series, classification, tolerances, designations and diameter formulas. Two appendixes and 12 tables are included. Copies of the 21-page standard are available from the American Society of Mechanical Engineers for $1.25 each.

Ring-Joint Gaskets and Grooves for Steel Pipe Flanges—ASA B16.20-1952: Covered in this new standard for gaskets and grooves are types, sizes, materials, dimensions, tolerances, finishes, identification numbers and markings. Two tables are included in the 11-page standard; copies are available from the American Society of Mechanical Engineers for $1.00 each.

Stainless Steel Pipe—ASA B36.19-1952: Revised from the 1949 edition because of demands for a lighter wall pipe, this standard incorporates a new schedule 5S pipe classification supplementing the regular 10S, 40S and 80S schedules. Copies of the 5-page revision, which contains two tables, are available from the American Society of Mechanical Engineers for $1.00 each.

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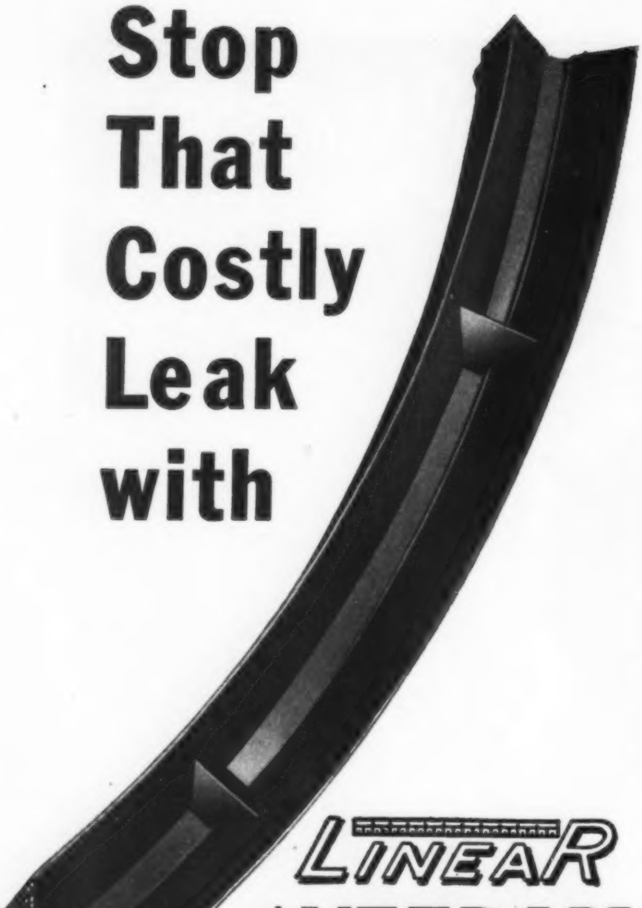

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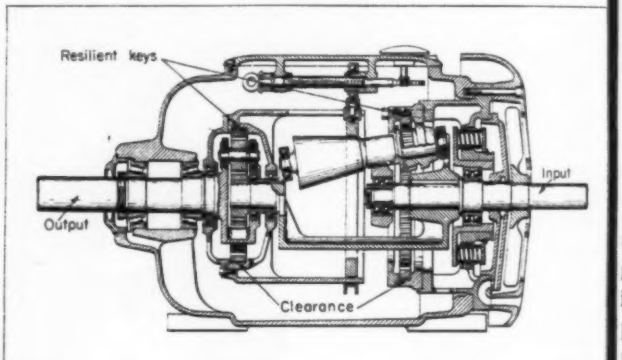
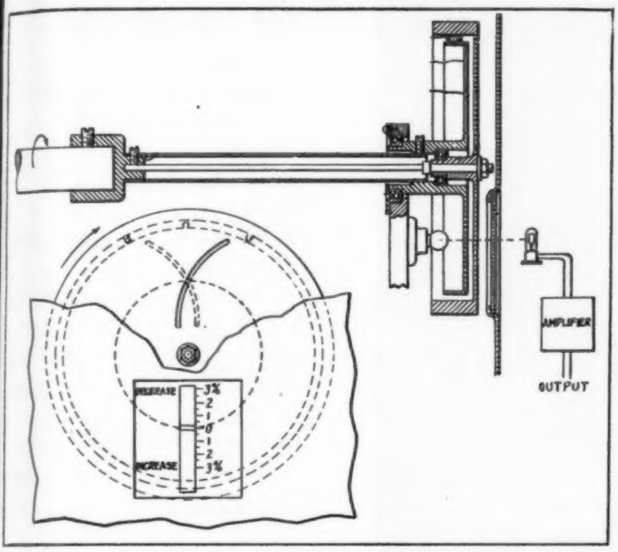
NOTEWORTHY Patents

RESILIENT RING-GEAR MOUNTINGS in a variable-speed transmission provide equal distribution of planet-gear tooth loads. Outside diameters of these internal gears are slightly less than the bores in which they are carried. Mating semicircular keyways in the bores and outer surfaces of the gears accommodate a series of round keys made of resilient stock. Held axially in the bores by retaining rings, the gears are thus both keyed and permitted to seek radial location to distribute the planet-gear loads equally. Three of the planet gears are integral with cone-shaped rollers carried on antifriction bearings in radial slots



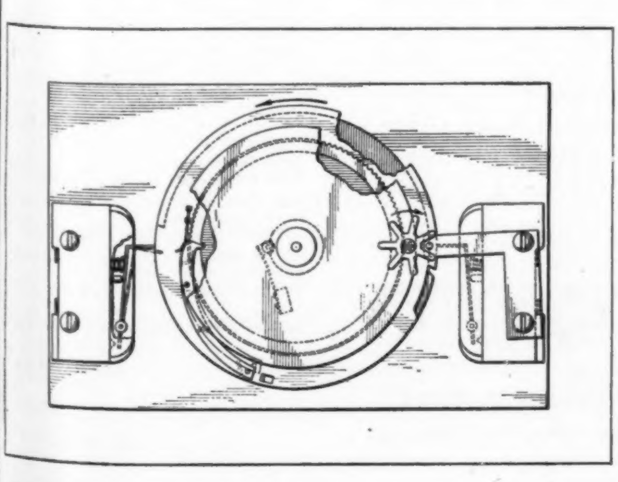
of a driven cage. Contact pressure between the rollers and outer friction elements of the transmission originates from axial thrust of a spring-loaded idler ring on the inner end of the input shaft. Radial component of this thrust tends to displace the canted rollers outward, thus maintaining contact pressure between the rollers and friction rings, one of which is adjustable laterally for changing output speed of the transmission. Input shaft of the unit carries a fan which circulates cooling air over the housing. Patent No. 2,580,392 assigned to the Falk Corp. by Alfred G. Bade.

PINPOINT INDICATION of rotational speed variation is accomplished uniquely by intermittent transmission of a light beam through reverse-curved slots in two tandem-positioned flywheel disks. Both disks are driven at nominal speed from a common coupling but because of unequal disk inertia and driveshaft rigidity they are affected differently by coupling speed changes. Under accelerations, the heavier disk lags or advances with respect to the lighter one causing the curved slots to change relative position. This alters the radial location of the apparent light aperture with respect to a calibrated scale, thus visually indicating speed change. The transient beam is said to be suitable for energizing a photoelectric cell to



impulse a corrective speed control circuit. Patent 2,579,349 assigned to General Electric Co. by Edward C. Vrooman.

WEEKLY CYCLE INTERVALS are controlled in a synchronous-motor timer through switch cams energized by a starwheel-driven differential gear. During the off-cycle period the cams remain idle, being positioned so by a leaf-spring roller detent. Comprised of two separate disk assemblies, the intermittent gear train revolves as a unit at a speed of one revolution per hour. One of the disks carries the starwheel pinion and is pinned to the drive shaft; the other is journalled on the same shaft, but geared to the first through peripheral teeth in mesh with the pinion. A tooth ratio of 1 to 24 combined with hourly indexing of the seven-point starwheel rotates the second disk, with respect to the first, one revolution per week. On completion of the weekly cycle, a normally inactive spring-loaded contact arm on the pinned disk swings about its fulcrum to the extent permitted by a notched plate attached to the gear disk. When in tripped position, the arm engages a driving lug on the cam assembly and drives the switch cams in



This eye spots *fast-moving trouble*

The Kodak High Speed Camera is shown here recording on film what happens at the "break" of a relay. Electrical aspects, shown on an oscilloscope, are recorded simultaneously on the same film by means of a special attachment.

When trouble is hidden in a blur of speed too fast to see, the cause is hard to find. Here's the way to get the answer in a hurry without costly, tedious cut-and-try experimentation.

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This high speed "eye" is daily solving complex problems of design, production, and product performance—problems where usual methods of analysis would be slow and costly. One manufacturer projects high speed movies within two hours after they are taken—the solution to a problem is on the drawing board the same morning it is discovered. We'd be glad to send you, with our compliments, a folder showing how this company uses the Kodak High Speed Camera so effectively. Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.

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Cutaway view showing PARKER O-rings in control valve of Ross Hydrapower Steering Gear.

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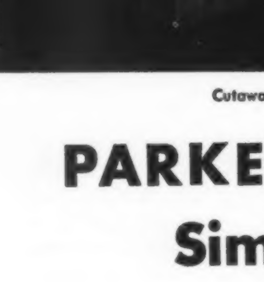

Cross section drawing of O-ring in groove, sealing under pressure.

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PARKER is the one source for *all* standard O-rings to meet specifications covering fuel, hydraulic and engine oil services . . . and for special service O-rings of tested and approved compounds. Ask your PARKER O-ring Distributor (see right) for Catalog 5100, or write The PARKER Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

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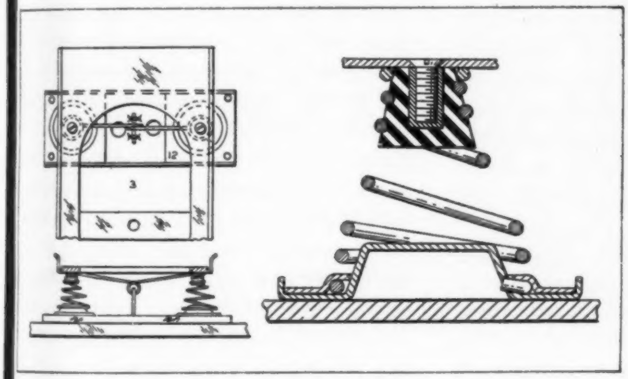
CANADA
Railway & Power Engineering Corp., Ltd.

unison with the gear assembly during the ensuing hour. Design of the cams determines the on-cycle period of the timer up to one full hour. Patent 2,582,-285 assigned to the R. W. Cramer Co. Inc. by Eugene L. Schellens.

CONICAL RUBBER BUMPERS with insert-molded nuts serve also as anchors in a conical-spring vibration isolator, thus simplifying the problem of fastening the spring apexes to equipment or platforms. Further, they provide damping effect through intimate contact with the coils in radiused grooves molded in the bumpers' outer surfaces. Coils at the large end of the springs are retained in circular pressed-steel base plates. Tendency of the coils to unwrap when compressed is resisted through the engagement of



turned-in ends of the base coils with punched holes in the bottom plates. Raised center portions of these plates provide striking surfaces for the bumpers to limit spring travel under severe compressive loads. Cantilever helper springs between each pair of isolators help relieve the coil springs of shock loads and prevent excessive rebound of the suspended mass. Patent 2,581,416 assigned to the United States of America by James W. Irby and Wilbur Johannesburg.

A COMPREHENSIVE PROGRAM for adequately recognizing and rewarding government employee-inventors is described in a publication just issued by the Government Patents Board. Entitled "A Proposed Government Incentives, Awards, and Rewards Program with Respect to Government Employees," the booklet is the work of an interagency committee appointed to study the subject and submit recommendations to the Chairman of the Board, Archie M. Palmer.

The report discusses and analyzes the problems involved in such a program, examines already existing statutory provisions and compares them with the practices and experiences of American industry and of foreign governments.

The new publication may be purchased from the Government Printing Office, Washington 25, D. C. for 15 cents a copy.

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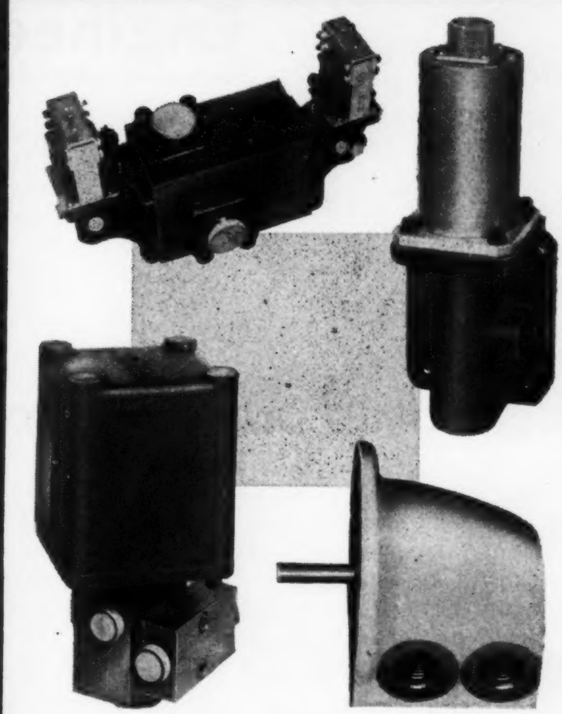

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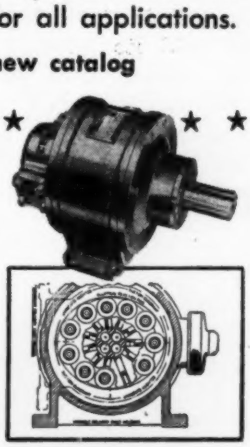

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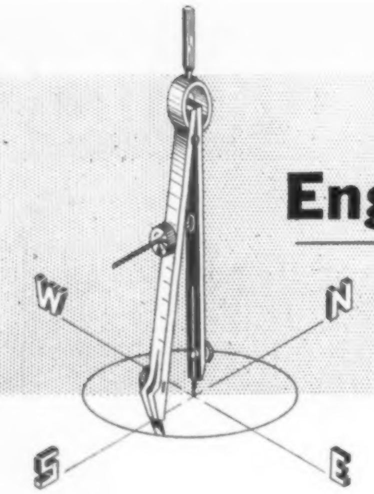


Engineering News Roundup

Metal Show Scheduled for October 20

Exhibits at the 34th annual Metal Show will occupy nearly five acres of floor space, and over 400 firms will be represented. Scheduled for October 20 through 24, the National Metal Exposition will take place at the Convention Halls in Philadelphia, Pa.

Theme of the meeting is "Metal Keeps the Peace," and the stated purpose is "to bring together the experience, the knowledge and the means for more effective use of metals in the making of products for civilian use, and for the making of products that will insure our defense against aggression, and thus guarantee our security and liberty."

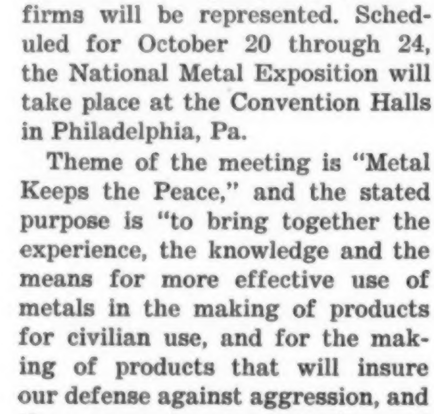
In conjunction with the exposition, the National Metal Congress will hold its meeting on October 18th through 24th. In addition to the space devoted to exhibits, thousands of square feet of space have been set aside for technical meetings, forums, lectures and other activities, which will continue throughout both sessions. Sponsors of the technical meetings are ASM, AWS, AIMME, and the Society for Non-Destructive Testing. The week-long show is sponsored by the American Society for Metals.

Further information regarding dates and subjects of meetings, and reservations, can be obtained from W. H. Eisenman, Managing Director, National Metal Congress and Exposition, 7301 Euclid Ave., Cleveland 3, Ohio.

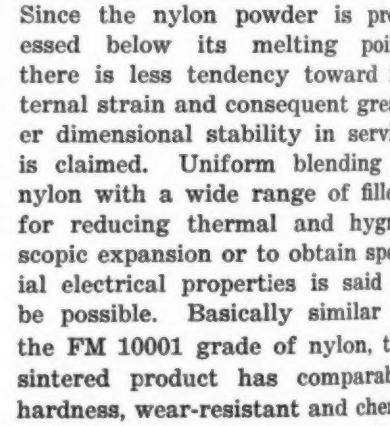
Nylon Powder Processed By Powder-Metal Techniques

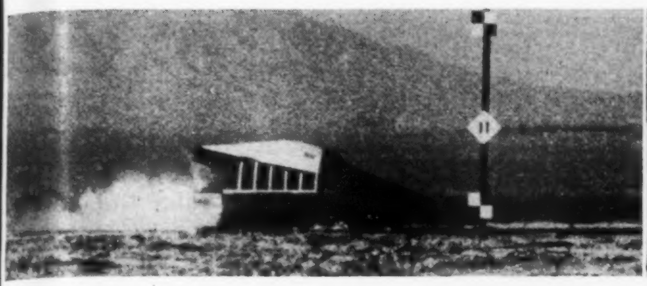
A recently developed nylon powder, produced by a special chemical process, is suitable for processing by sintering techniques, similar to those of powder metallurgy. The finely divided powder, having a particle size below 10 microns, is known as Nylasint 66, and is produced by National Polymer Products Inc., a subsidiary of the Polymer Corp.

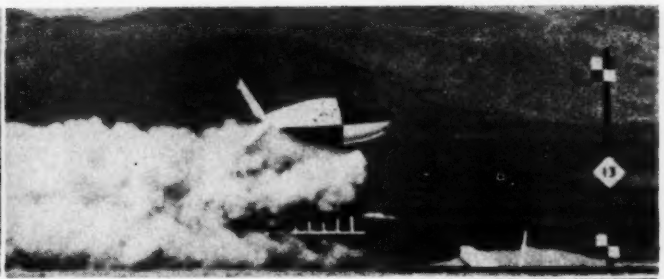
The powder lends itself to the production of cold-pressed and sintered bearings, gears, cam rollers and valve seats, and appears to have certain advantages due to the processing technique involved. Since the nylon powder is processed below its melting point, there is less tendency toward internal strain and consequent greater dimensional stability in service is claimed. Uniform blending of nylon with a wide range of fillers for reducing thermal and hygroscopic expansion or to obtain special electrical properties is said to be possible. Basically similar to the FM 10001 grade of nylon, the sintered product has comparable hardness, wear-resistant and chemical properties, but somewhat lower toughness than equivalent molded products. Laboratory and field tests indicate that bearings made by cold pressing and sintering Nylasint have a low coefficient of friction and show great promise for applications where operation without lubrication is required.



The handsome head of hair on "Aluminum Al" is actually aluminum oxide. Although aluminum usually furnishes its own protective coating, when the surface is scratched under mercury the protective film does not form, and aluminum oxide sprouts out along the scratches in uncontrolled, hairlike growth.

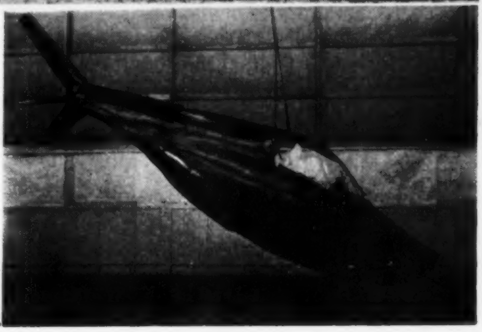






Cockpit Capsule Expelled From Plane by Rocket Charge

While traveling at 760 mph, a cockpit capsule developed by Douglas Aircraft is ejected from a test rig by a rocket charge. Designed to help pilots escape from jet fighters, the capsule releases a small parachute aft to slow it down. A mockup is shown at right



Designed to help a pilot escape safely from fighter airplanes traveling at supersonic speeds in the stratosphere, a cockpit capsule developed by Douglas Aircraft Co. uses a rocket charge to expel the entire cockpit clear of the rest of the airplane. The cockpit, which has been under development since 1948, has passed a series of practical tests which have shown its ability to perform under rough conditions.

In a critical emergency the pilot sets off the rocket charge and the cockpit is catapulted into space. Immediately, three fins unfold in its aft end to stabilize it, and a small parachute releases to slow it down. When a safe speed is reached, tension on the small chute pulls out a main chute which suspends the cockpit and pilot in their descent to the ground or water. As the chutes unfold deceleration from 1100 fps to 300 fps occurs in about five seconds.

The cockpit capsule is sealed and pressurized to protect the pilot against fatal atmospheric conditions above 50,000 feet altitude. If landing is made on water the watertight capsule rests on its side momentarily as the pilot releases, in one motion, the parachute and a boom holding the plane's storage battery. The battery lowers automatically into the water below the compartment as a weighted keel to bring the compartment upright. Survival gear similar to that stored on a Navy life raft is included in a storage cell, and on water, fresh air is pumped into the compartment by motion of the waves. The capsule is insulated against cold weather.

Final tests were conducted on the 10,000 foot Naval aero-ballistic test track at Inyokern, Calif. to determine if the cockpit could be ejected satisfactorily at the speed of sound near sea level. Fitted to a test rig simulating the forward part of a fighter airplane, the capsule was catapulted down the track at a speed close to 760 miles an hour by two stages of rocket propulsion, one following the other in immediate sequence. Each stage produced well over 100,000 pounds of thrust to propel the test rig at speeds believed to be faster than land vehicles have ever moved.

After the apparatus sped several thousand feet down the track, the cockpit capsule ejection charge was automatically ignited, fins snapped open, and the capsule was hurled in a directionally stable parabolic flight path. Navy officials said the principles utilized in the development of this capsule can be applied to all aircraft cockpits.

Engineers Still in Short Supply

A current survey by the Engineering Manpower Commission indicates that there is a need for about 50,000 engineers. The survey, not yet completed, shows a radical difference from the results of a survey conducted in 1951, which indicated a need for 70,000 to 80,000 engineers.

The closing of this gap is said to be due to better utilization of engineers by industry, the anticipated return of some engineers from the armed services, and the current peak in tooling-up requirements for defense production.

In mentioning these figures, the Engineering Manpower Commission is careful to point out that the reduction does not indicate an automatic solution to the shortage of engineers. Estimated requirements for engineers in industry alone is 30,000 annually. Less than that will be produced annually. In 1953, an estimated 20,000 student engineers will graduate. In 1954, the graduating classes will only turn out about 17,000 engineers, and in 1955 graduates will total about 20,000.

As a solution, the Engineering Manpower Commission recommends three policies:

1. To work toward an intelligent policy as regards draft-age graduate engineers and those holding reserve classifications. Such engineers should be carefully screened before being recalled to active duty, to insure that their skill will be best utilized.

2. To encourage qualified youth to consider the opportunities in engineering and to enter engineering colleges.

3. To exert every effort to utilize all available engineering personnel in industry, government, and the military to the best possible advantage.

Definite progress on the last two points has been reported. Local industry and educators have been working co-operatively to encourage talented secondary school

youths to consider the opportunities in engineering and science. A definite trend toward "streamlining" the engineering departments of industrial firms, as well as a better utilization of young engineers has been noted.

The first point, that of revising the draft policies with regard to engineers, is still a problem. Draft boards in some sectors cooperate fully, although in many places young engineers are being indiscriminately inducted without due regard for their skills.

Three Nations Agree On Standards Unification

Agreement has been reached on the setting up of a permanent organization to work on unification of engineering standards between the United States, Canada and Great Britain. Of importance to defense projects, the program to be set up will attempt to reach general accord on major standards.

Three delegations from the three countries were represented by Vice-Admiral George F. Hussey Jr., managing director of the American Standards Association, Stanley J. Hurley of the British Standards Institution, and James G. Morrow of the Canadian Standards Association. The U. S. government was represented by Howard Coonley, director of conservation of DPA, who acted as permanent chairman, plus several other government officials.

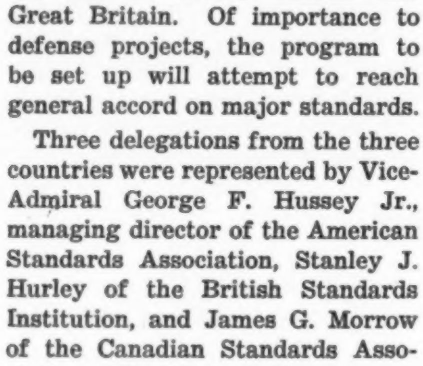
Permanent committees were named in several fields to study details and report back to the next conference meeting on October 14. Drafting standards and practices, screw threads, pipe threads, threads and fittings for gas cylinders, and fits and tolerances will all be subjects of discussion. Of major importance will be the expected agreement on drafting practices, since it should make drawings mutually understandable between the three countries, and save thousands of man-hours.

A dramatic illustration of 25 years of progress is shown by the two bearings. The small bearing held by Charles L. McCuen, GM vice president, is a typical connecting rod bearing used in modern automotive engines. The large bearing in front of A. F. Underwood—having fifteen times the area—would be required to carry the loads now being handled by the small bearing if no progress in design and construction had been made.

Single Government Contract Benefits Many Companies

A recent study reveals that 381 firms participated directly in a single government contract, according to Westinghouse Electric Corp. About 44 per cent of the $17 million contract was passed along to subcontractors and suppliers. As an illustration of the "pebble-in-a-pool" effect started by this activity, Westinghouse found that one major subcontractor had in turn spent 41.6 per cent of his contracted amount with other suppliers, comprising 254 large and small businesses.

Pointing up the importance of small business in meeting defense production contracts, the survey revealed that 31.5 per cent of the original amount spent by Westinghouse went to firms with less than 500 employees. The large subcontractor, in turn, was also found to have spent a major percentage with small businesses.



The giant of all tires—10 feet tall and 4 feet wide—is now being used by R. G. LeTourneau Inc. on an experimental "swamp buggy" now undergoing development. Designed to operate at air pressures from 10 to 15 psi, two of these huge tires are mounted on the front wheels of a 35-ton capacity earthmover.

Jet Engine Controls Tested Without Even Leaving Ground

Not even an engine will be needed for testing jet engine controls in a new research laboratory being established by Minneapolis-Honeywell Regulator Co. Believed to represent the most comprehensive engine analog work ever attempted by a control manufacturer, a network of highly complex electronic computers-controllers and relays will permit jet engine controls to be designed and proved without ever leaving the ground.

"Time consuming and expensive flight tests during development will thus be eliminated." Alex B. Chudyk, chief controls engineer, explained. "Moreover, with this electronic set-up, our engineers will be able to acquire much more test data than previously possible and cut down on research time as well."

The electronic system, heart of which is an analog computer, makes it possible to stimulate the characteristics of any jet engine under all kinds of flight conditions. Performance of controls is recorded automatically. Engineers then can quickly determine whether the engine "likes" the type of control being tested. Duplication of the whole gamut of engine positions—idle, takeoff, cruise, augmented thrust—and electronic injection of such flight conditions as speed, altitude and fuel temperature gives the engineers a much wider range of experiment than flight testing,

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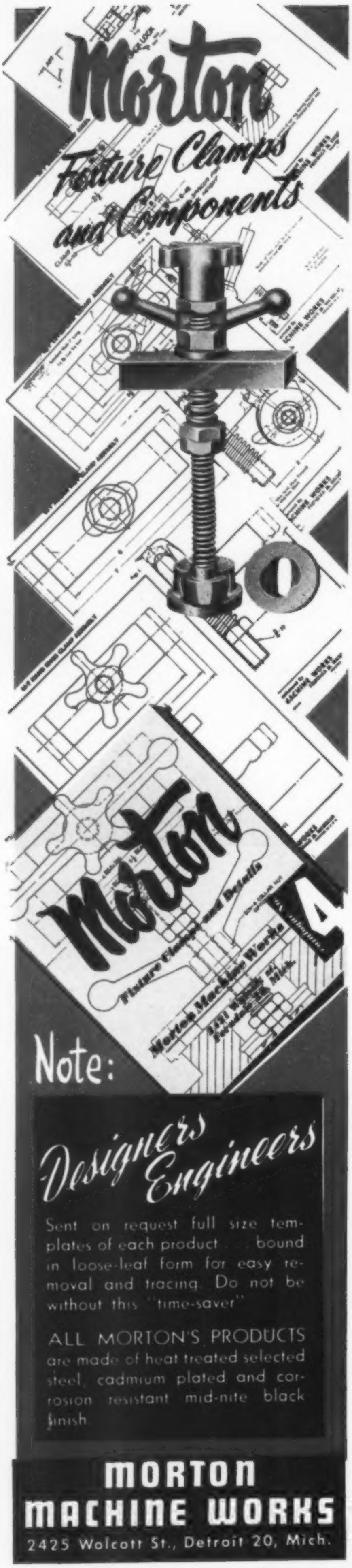


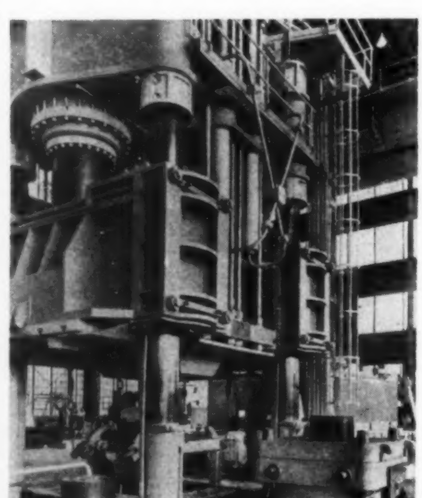
Chudyk said.

"When you flight test a control," he added, "and there is a failure, you have to land and start over. If it works, you are never sure whether it is because of the peculiarity of the particular type of engine. The lab does away with this hit and miss guesswork and it gives us considerably more knowledge of a control's performance in all types of engines and flying conditions before it is ready for its wings."

Huge Press Designed For Forming or Forging

A huge vertical press recently installed at the Babcock and Wilcox Co. does double duty as both a forming and a forging press. The new press, with a normal capacity of 6500 tons or an intensified capacity of 8500 tons, can produce a rough hollow forging up to 35 inches in outside diameter with 4½-inch walls. Length of seamless hollow forgings can be up to 22 feet.

Ingenious design has made possible the use of this press for forming heavy boiler plate as well as forging. Massive bending beams 42 feet long stand at one side of the open-end press. At 90 degrees from the bending beams is the piercing pot, used for ingot piercing. Either of these two beds can be moved under the press ram between the four 41-ton steel supporting columns.



The press has made possible a new method of forming heavy wall, hollow forgings by piercing and drawing an ingot. Until now it has been necessary to make such pieces from steel plate rolled and welded at the seam, or from a solid forging with the center bored out. With the new equipment, the heated ingot is pierced, then taken to a horizontal draw bench where it is forced through a series of ring dies to produce a seamless, hollow forging. Ingots or billets of varying cross-sections such as hexagon, octagons, rounds, or squares with round corners, can be successfully shaped.

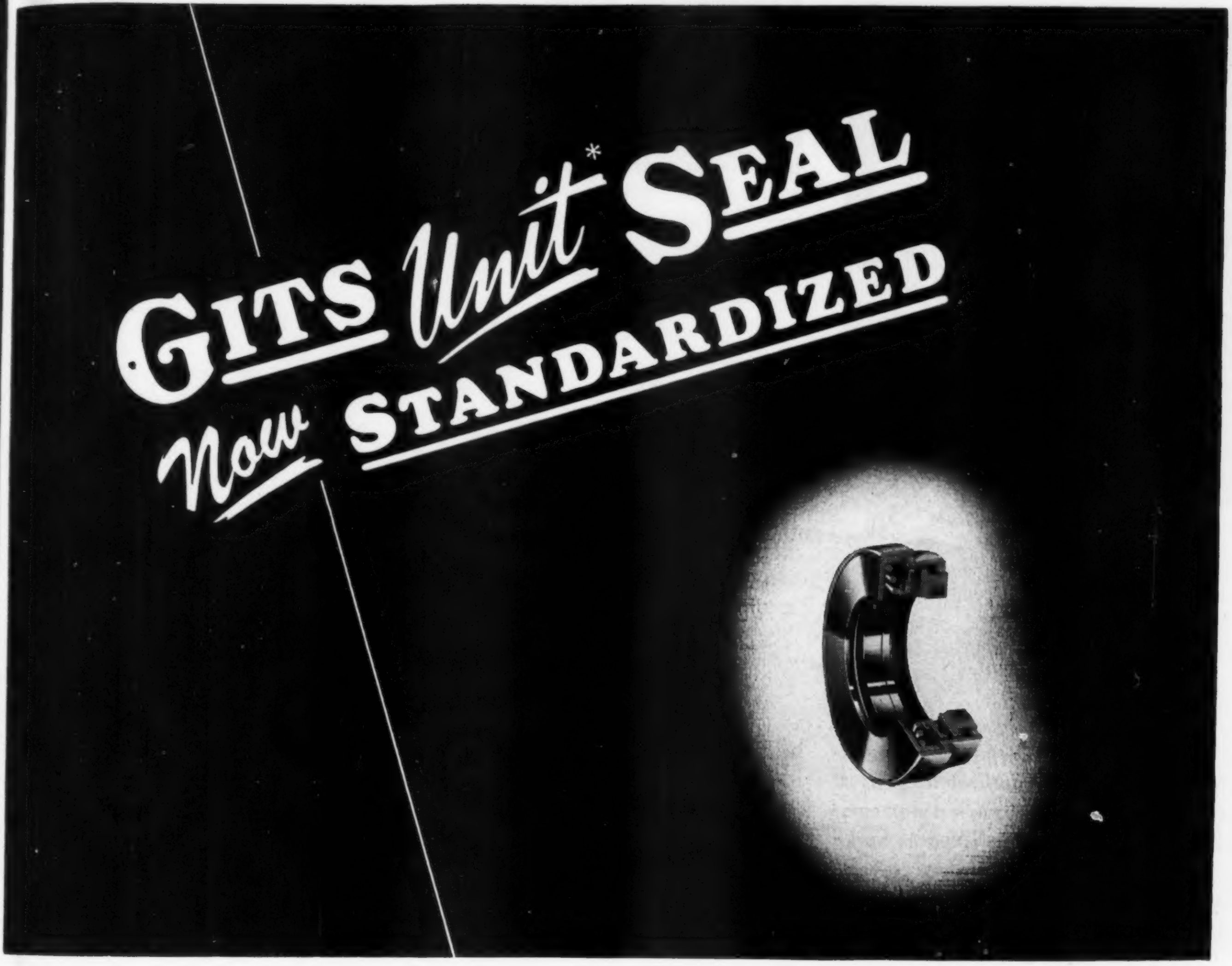
The press is 64 feet high, from the bottom of the pit to the top of the press. Each of its four supporting columns is a giant steel pillar 52 feet high and 26 inches in diameter. The largest of the three press platens used weighs 200 tons. Maximum weight of the cropped ingot which the equipment can handle is 26,000 pounds.

Preventing Corrosion on Ball Bearings in Storage

Recent investigations of corrosion in ball bearings with brass retainers have shown that this corrosion, usually occurring during storage, can be prevented by two simple methods. The first is the use of a corrosion inhibitor which will prevent electrolytic corrosion. As an alternate, steel, plastic or a nonferrous metal or alloy less susceptible to chemical attack than brass can be used for the retainer.

The study by the Naval Research Laboratory started when the occurrence of corrosion in the form of fine specks was observed on the steel parts of brass-retainer ball bearings in maintenance depots and laboratories. Corrosion occurred even after storage in rooms controlled at temperatures of 70 to 80 F and at 30 to 40 per cent relative humidity, and seemed to occur no matter whether petroleum, synthetic, or diester type lubricants were used.

Realizing that the corrosion encountered in laboratory tests was electrolytic in nature, and probably accelerated by small quantities of



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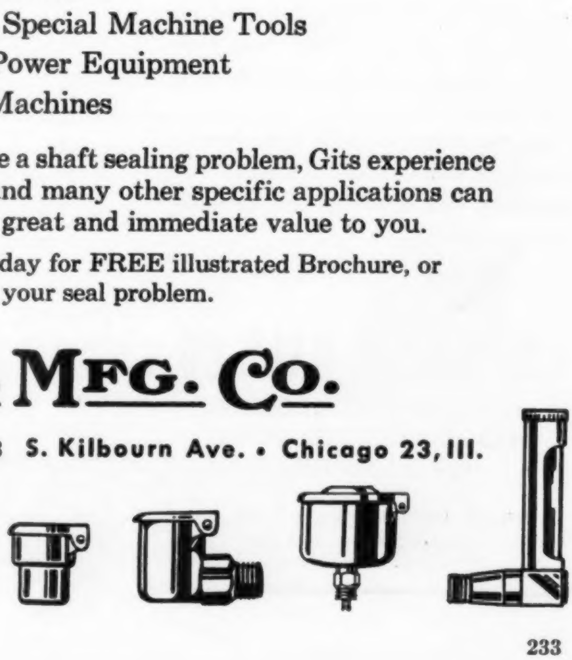

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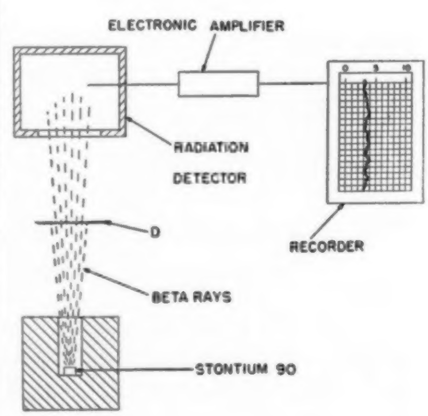
acids formed by oxidation or hydrolysis of the lubricant, NRL researchers concentrated on combining the acid-neutralizing qualities of an amine with the rust-inhibiting qualities of an organic acid. They developed several amine-acid complexes which satisfactorily limit corrosion and rust. These lubricants, however, are designed to perform at low temperatures. For high - temperature performance, metal deactivators or neutralizers with a higher heat stability deserve study.

Since corrosion at low humidities has been found serious only in the presence of brass, a suggestion has also been made that use of this material for separators in ball bearings could be deferred in favor of materials less susceptible to chemical attack.

Radioactive By-Products Measure Weight of Coating

One of the earlier industrial applications of radioactive by-products from atomic fission has been the measurement of weight or coating thickness of continuously moving materials. Produced as by-products of atomic bomb research



projects, many of these radioisotopes are receiving attention by manufacturers, and new equipment is now being produced commercially to utilize these by-products in gaging.

One of the recent applications has been installed at Standard Register Co. for continuously gaging the thickness of carbon ink deposited on a moving web of one-time carbon paper. A uniform, even coating of carbon ink is necessary to produce high-quality carbon paper for multiple forms, and the radioisotope equipment has proved successful in the delicate task of maintaining constant thickness.

Early attempts to provide a method of gaging consisted of looking at samples of the finished carbon paper placed in front of an incandescent light source. This method, however, proved unreliable. A later method of checking the amount of carbon coating deposited by periodic sampling and weighing of coating also proved unsuccessful, since errors were high in the weighing method. The new equipment using radioactive material has provided an extremely satisfactory level of accuracy.

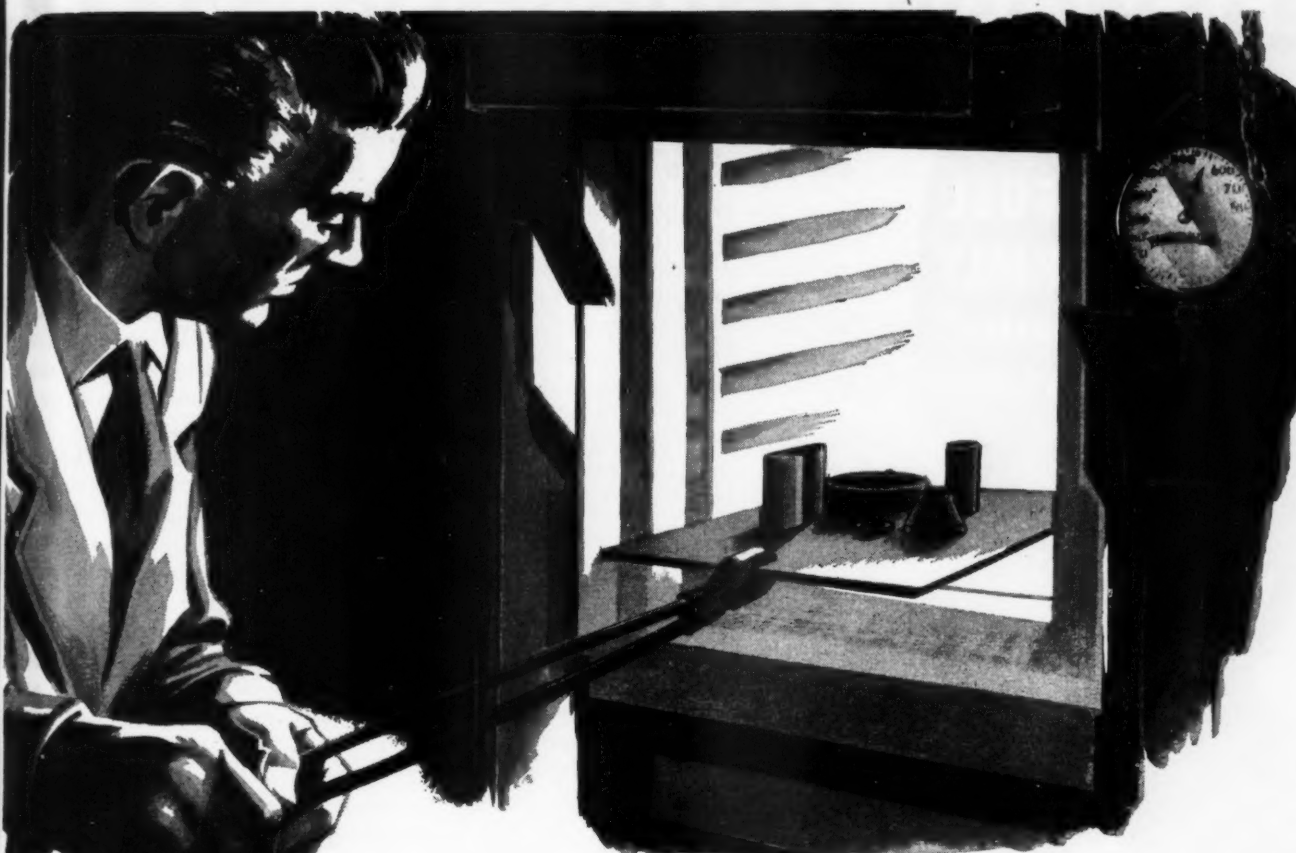
Basically, the equipment consists of a radioactive material, strontium-90, which constantly throws off beta rays at a substantially constant radiation level. This radioactive material has a half-life of 25 years. Any material placed between the radioactive strontium and the radiation detector reduces the transmission of radiation by absorption. Thus, the reduction in radiation is a direct measurement of the thickness or volume of the material. By first gaging a plain sheet of paper for use as a standard, thickness of the carbon coating can be measured directly. Although at present the gaging instrument is set up only to measure coating thickness, control of coating thickness can be effected using the same principles.

♦

Raytheon Mfg. Co., Waltham, Mass., recently opened a new building which will be used by the research division in carrying on a major portion of the company's $2,000,000 transistor program. The building will also be utilized for engineering and manufacturing activities by the company's equipment divisions.

♦

All manufacturing and operating facilities of the former Wheelco Instruments Co., which is now **Wheelco Instruments Div.,** of **Barber-Colman Co.,** have been transferred to Rockford, Ill.



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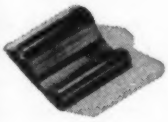

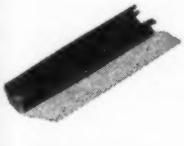

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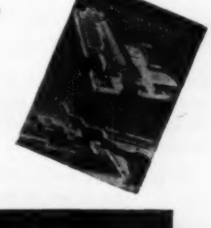

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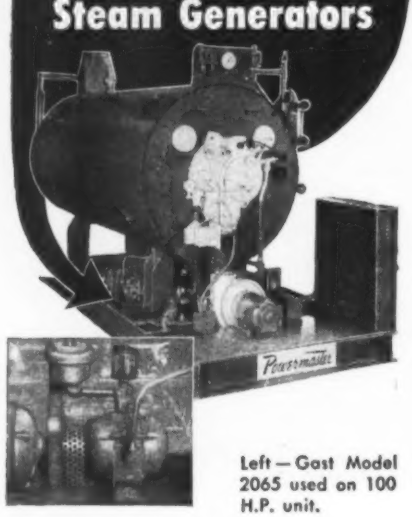

Left — Gast Model 2065 used on 100 H.P. unit.

PROBLEM: Select a compressor to supply uniform, pulseless air volume for atomizing fuel oil in the combustion chamber of Orr & Sembower "Powermaster" Boilers.

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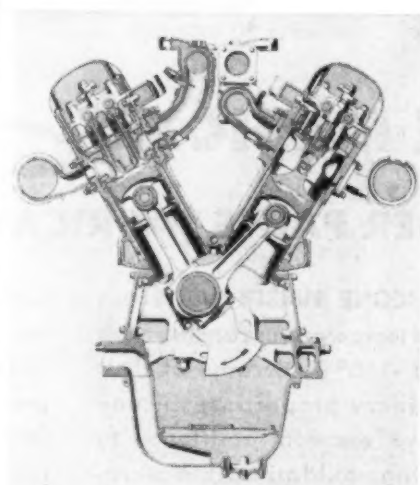
Engineering News

Marine Diesel Engines Use Aluminum Extensively

A new family of four-cycle, automotive type diesel engines developed by Packard Motor Car Co. for marine use makes extensive use of aluminum as a method of reducing weight. Two models are now in production for the Navy—a 6-cylinder and a 60-deg V-12—both equipped with turbochargers, and rated 300 and 600 brake horse power respectively for continuous duty at 2000 rpm. The engines are claimed to have the lowest specific weight (lb/bhp) of any diesel engine in production today.

Distinguishing characteristic of the engines is the adoption of a basic standardized cylinder assembly design which promotes complete interchangeability of most



major parts. Combustion chamber design employs a spherical precombustion chamber precision-cast in the alloy steel cylinder head. A pintle type fuel injector mounted in the cylinder head injects metered quantities of fuel directly into the precombustion chamber where ignition starts and peak pressure occurs. A dispersing cone on the piston dome causes the burning mixture to mushroom, mixing the fuel and the compressed air thoroughly to provide complete burning. Since the peak pressure in the main combustion chamber is lower than that in the pre-combustion chamber, the new engine design is claimed to facilitate high-speed operation and quick cold starting.

Aluminum is employed throughout the structure making possible a low total weight of only 2200 pounds for the 300-bhp engine and 3250 pounds for the V-12. The cylinder block and crankcase is an integral casting of aluminum. The oil pan is also aluminum, as are the valve cover, timing gear cover, supercharger, intake and exhaust manifolds, accessory housings and cover plates, pistons, and other detail parts. Pistons are aluminum-alloy permanent-mold castings. They are fitted with five rings, the top three being compression rings, and the lower two special tapered oil-control rings.

The seven-bearing crankshaft is an alloy steel drop forging. Main bearings are steel-back with a silver coating and a thin overlay of high-lead and tin. The engine is fresh-water cooled, using sea-water type heat exchangers. Pressure lubrication is provided to all bearings and other major points, with cylinder wall and wrist pin lubrication by splash feed.

Corrosion Prevented By "Impregnating" Metals

A process which gives high corrosion resistance to mild steel and other ferrous metals, yet does not change dimensions of the part appreciably, has been announced by Stanwood Oil Corp. The process, described as thermochemical treatment of metals, requires standard coating and heat treatment equipment which is specially controlled. Application requires a chemically clean surface which is treated hot under these controlled conditions, although the heat employed is not enough to temper or soften cold-rolled or other work-hardened steel.

Exclusive licensing rights to this Permyron process have been announced by Stanwood. According to the company, the process uses a low-cost material which is absorbed into the pores of the metal, so that dimensions are not changed appreciably. The coating forms a dense undercoating or primer for paint or other decorative finishes, either baked or air-dried. The resulting base is highly resistant to

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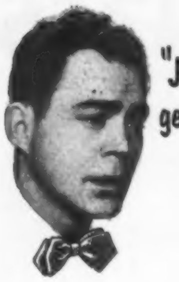
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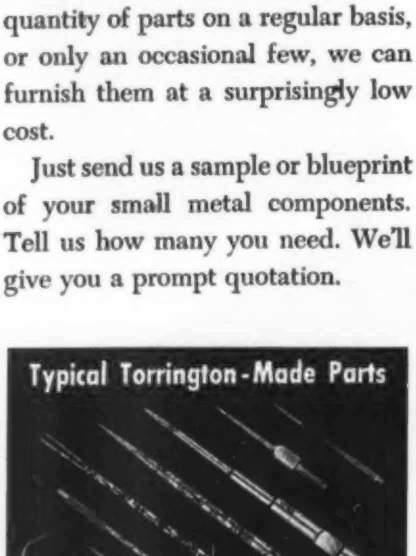

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attack by ordinary weathering or acid conditions and has flexibility sufficient to maintain bonding power and corrosion protection after considerable deformation.

After testing, Stanwood reports, the Chemical Warfare Service, as well as a number of companies, has approved use of the process. Cost of application per square foot or piece is said to be substantially the same as that of present finishing methods.

Build Second Nuclear Sub

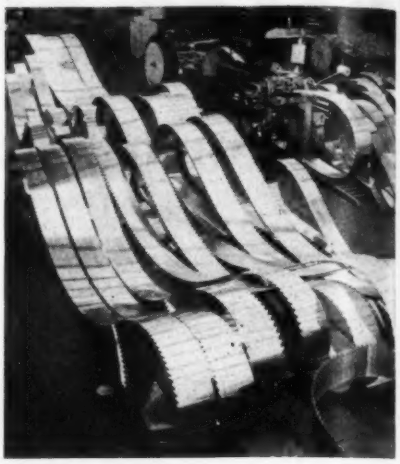
A second nuclear-powered submarine, of the same general design as the U. S. S. Nautilus now under construction, will be built by the Electric Boat Div., General Dynamics Corp. Although the general design is the same, the nuclear power plant is of a different design, utilizing an intermediate neutron energy reactor and a liquid-metal coolant. Designed like a land-based prototype now under construction at West Milton, N. Y., the new power plant will be built by the General Electric Co.

Estimated costs to the Navy for construction of the second nuclear submarine will be $32.7 million. This figure does not include costs for the nuclear portion of the power plant.

Operating characteristics will be similar to those of the Nautilus. The second nuclear submarine will be able to operate under water at more than 20 knots and remain submerged for long periods of time without even a snorkel breathing tube to the surface. It will have a cruising range comparable to that of the Nautilus, and in considerable excess of that of present fleet-type submarines.

•

Ferro Corp., Cleveland, manufacturer of porcelain enamel products and allied industrial equipment, has opened a new million-dollar glass fiber plant in Nashville, Tenn., which will specialize in the production of glass fiber for plastic reinforcement. The new plant will produce continuously rolled mats 48 inches in width.



50-foot endless band-saw blades, shown ready for shipment from the Simonds Saw and Steel Co., travel at express-train speed and bend as often as 440 times a minute. Atomic-hydrogen welding joins the ends of manufactured blades, and has been successfully used for the last seven or eight years.

Growth of Company Cited At Du Pont 150th Birthday

America is "as full of promise for the future" as it was 150 years ago, declared Crawford H. Greenewalt, president of Du Pont at the company's 150th anniversary ceremonies on July 18. "The possibilities in increased productivity alone are enough to expand our standard of living substantially beyond its present high level," he predicted.

Speaking at the site of the first Du Pont mill on Brandywine Creek on the outskirts of Wilmington, Mr. Greenewalt traced the development of E. I. du Pont de Nemours and Co. from a relatively small organization in 1802 to the massive giant it is today. Three components went into this expansion, he said, "namely work, tools and leadership. Each of these components expresses the contribution of the people who participated in this venture. . . . No one of these three stands alone; each merges with the other until they become a whole, intimate and inseparable."

Du Pont today employs 87,000 men and women, is owned by more than 140,000 stock holders, sells thousands of chemical products to more than 75,000 customers and buys from more than 30,000 sup-

pliers. Originally the workers were a small group, said Mr. Greenewalt, "for the initial plant required but a few operators. . . . As the company grew and prospered over the years, new plants were built and more men and women from all parts of the country joined the ranks of the company. They rendered their service to the joint effort through good times and bad, often in times of danger and hardship. . . . Without their help this endeavor could not have succeeded."

Preferred-Numbers Series Recommended by ISO

Two recommendations concerning international adoption of a series of preferred members were unanimously approved by a technical committee of the International Standards Organization at a recent meeting. One document recommends four basic series of preferred numbers to be used in a given order of priority, and gives a fifth to be used in unusual cases. The other is a guide to the use of preferred numbers.

The first of the recommended series is the so called 5-series, in which the preferred numbers covering the range from 10 to 100 are: 10, 16, 25, 40, 63 and 100, representing a step-up of about 60 per cent. This 5-series has the coarsest grading of the group. If

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You can produce *positive photographic intermediates directly* from your engineering drawings by reproducing them on any one of four types of Kodagraph *Autopositive* Materials. To do the job—simply expose in your present equipment... and process in standard photographic solutions. No negative step. No darkroom handling—a fast, convenient room-light operation all the way.

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3. **Kodagraph Autopositive Film**—with its highly translucent Kodak safety film base—is especially valuable in reclaiming "hopelessly poor" tracings... and in reproducing extremely fine line detail. It is also widely used to reproduce catalog pages, etc., including half-tone illustrations.

4. **Kodagraph Autopositive Cloth**—is recommended for producing the most durable prints (nearly exact in scale) from drawings in good condition. Its base is white fabric—tough, crease-resistant, highly translucent.

Kodagraph Repro-Negative Paper, which is processed in the same manner as the Autopositive Materials and with the same speed and convenience, enables you to produce positive intermediates directly from blueprints, Van Dykes, and other negative "originals."

If you have any type of contact photocopying machine, you can get negative and positive reproductions of improved quality at lower cost with *Kodagraph Contact Paper.* Its high-contrast photographic emulsion produces photocopies which are easier to read . . . with dense photographic blacks, clean whites. And its extremely wide latitude and amazing uniformity end the need for split-second timing and trial-and-error testing.

Kodagraph Contact Cloth, with an extremely durable, translucent base and with similar emulsion characteristics, is widely used to produce long-lasting second originals from paper negatives. (Unwanted design detail on these negatives can be blocked out before printing.)

If you have an enlarger, projection printer, or process camera, Kodagraph Projection Papers will give you sharp, clean reproductions at any scale — dense photographic blacks, sparkling whites on a durable, Kodak-made paper base. Just the papers you need for reproducing your microfilm and other reduced-scale negatives!

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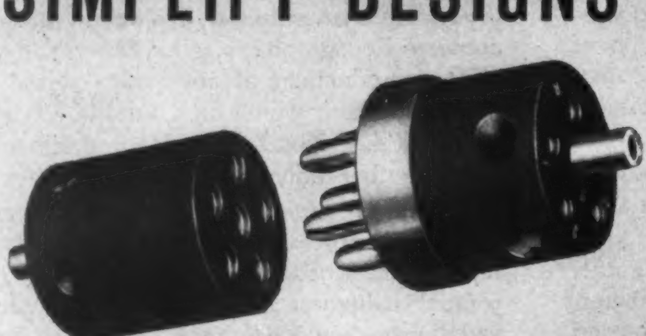

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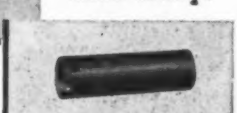

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this grading is too coarse, the designer can use the 10-series, in which the increase between consecutive numbers is 25 per cent. If still finer gradation is necessary the 20 and 40-series, with step-ups of 12 and 6 per cent, respectively, are available. An additional 80 series, to be used only in exceptional cases, gives a 3 per cent step-up.

The second ISO document just approved is a guide to the use of preferred numbers. It lays down the general principles of applying preferred numbers for various purposes, such as the establishment of a series of capacity ratings for a line of motors or a series of thicknesses for metal sheet.

Delegations from the standards organizations of 12 nations participated in the work of the committee. Head of the American delegation was Harold P. Westman of International Telephone and Telegraph Co.

Security Guide for Industry

Security methods and minimum security standards are covered in a new security guide published by the Defense Munitions Board. The booklet, *Standards for Plant Protection,* contains 53 pages and lists minimum standards for more than 90 separate security measures recommended to defense plants.

Application by private industry of the standards set forth in the booklet is not compulsory. The recommendations, based on the best practices now being followed within industry, are the result of several years of research and consultation.

The booklet, which can be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. for 20 cents, supplements a previous publication, *Principles for Plant Protection.*

•

A plant which is expected to be producing aluminum alloys by late fall will be built in Los Angeles by **Apex Smelting Co.** When completed, the plant will also produce magnesium alloys and zinc base die cast alloys.

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Jeffrey Chains and Sprockets are being put through the acid test of actual service on thousands of tough jobs . . . especially where the demand is for high-quality products. They are in universal use for unit machinery, for conveyors and bucket elevators, and for transmitting power. Follow the lead of those engineers who know the importance of "good chains and sprockets." Send for our new Catalog No. A-418 which goes into detail.

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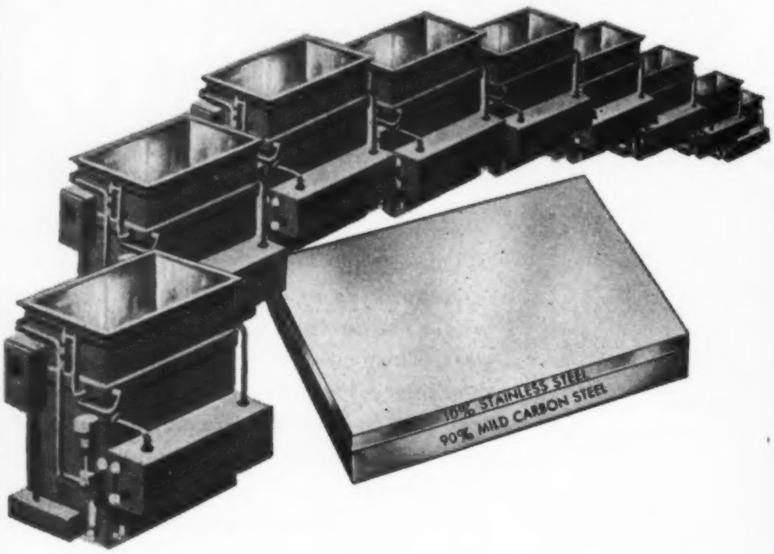

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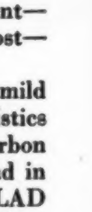

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Engineering News

New Glass Textile Yarns

High strength and great flexibility are characteristics of a new series of glass textile yarns being produced by the Fiber Glass Division of Libbey-Owens-Ford. The new series of "225" industrial yarns is considerably finer than the "150" series with which LOF started its operations a few months ago.

Primarily used in industrial cloth, electrical insulation and plastic lamination, the finer yarns are composed of strands running 22,500 yards to the pound. Each strand is composed of 204 separate continuous filaments of fiber glass each of which averages 0.00028-inch in diameter. Some of these yarns, for instance, will be made of a total of six strands or 1,224 of the individual continuous filaments, giving the final cloth its high strength and flexibility while retaining dielectric resistance and resistance to heat and chemicals.

•

Frank F. Rowell Sr., president of **Guardian Electric Mfg. Co.,** Chicago, died July 20. Mr. Rowell held many patents in the electrical control field.

Report on Materials

Effects of the steel stoppage will be "felt heavily for the next three to six months," according to Dr. John R. Steelman, acting head of the Office of Defense Mobilization, in a statement last month. Effects "will not be completely worked out of the military production program for an entire year." The most optimistic forecasts of steel production give a figure of 90 million tons, some 14 per cent below last year's production. In order to attain this output, steel production capacity would have to be increased materially over last year. And other estimates from completely qualified sources estimate that production of steel will not pass the 70 million ton mark.

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Self-Adjusting for Wear. New Dings fractional horsepower magnetic brakes automatically compensate for wear, requiring no adjustment for up to a million and a half stops.

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Compact. Dings brakes are space savers.

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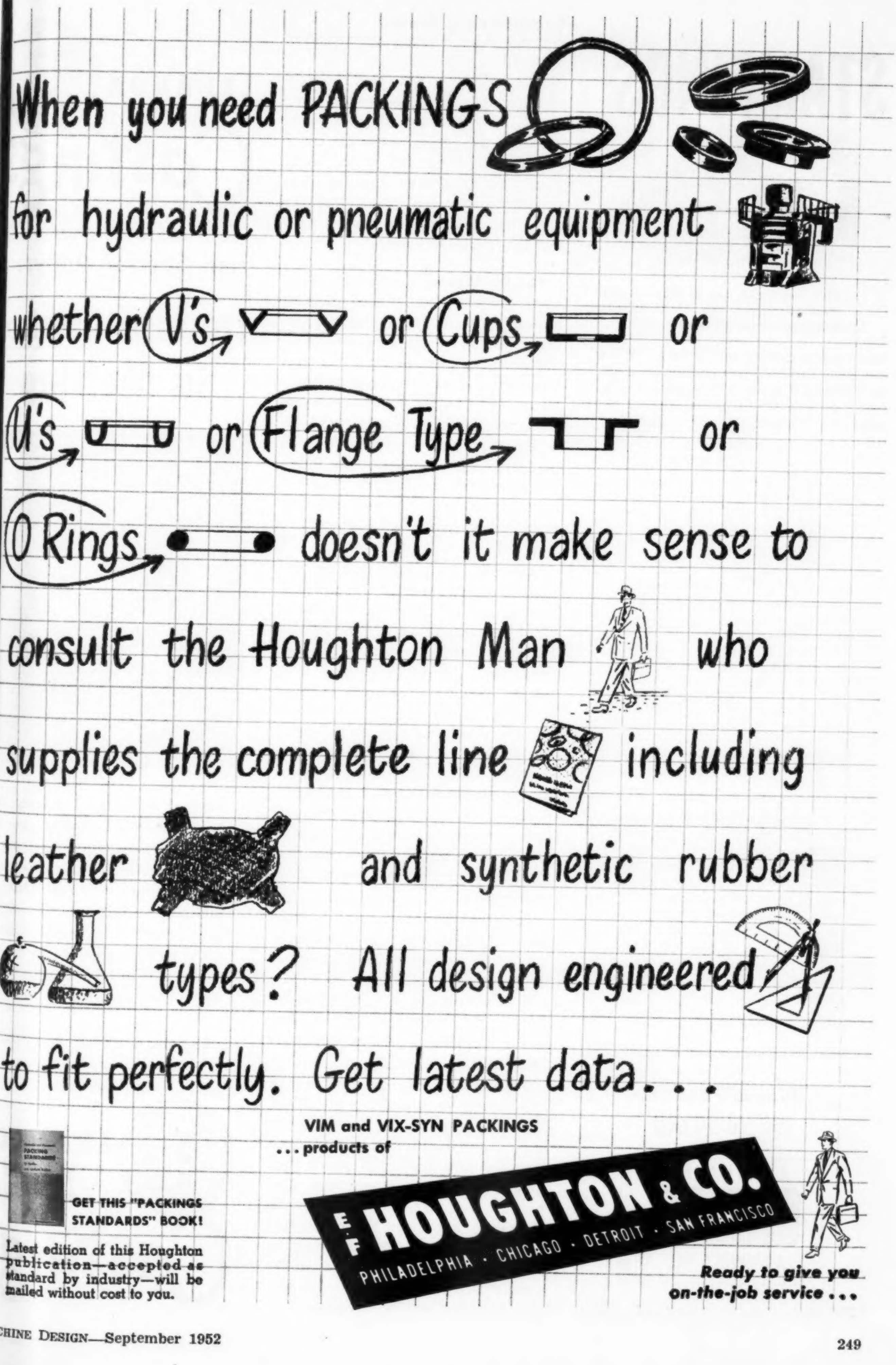
the strike have been a "creeping paralysis" of the defense program, as described by Defense Secretary Robert A. Lovett. At first, assemblers of end products were able to live off their inventories. As inventories for end products disappeared, defense output slowly dwindled, to the point that Mr. Lovett estimates a loss of 20 per cent of the output of defense goods expected during the current year. Defense production will probably not get into full swing until the end of the year, since assembly plants in some cases have yet to feel the shortage of components caused by the steel strike, and will probably be the last hit.

Pattern of Recovery: All CMP steel orders will be filled eventually, says NPA, although some of them will be months late. The major problem is the steel tonnage required for preferred defense programs, including the military, atomic energy and machine tool programs. The most urgent of these orders will probably be taken care of by the end of November. At the same time, tonnage set aside for the general preparedness program will be increased through the end of the year, although military steel deliveries probably won't be up to schedule until well into 1953.

In nonmilitary production, present second, third and fourth-quarter orders will stand although first-quarter 1953 allotments will be used to balance the supply and demand picture. Third-quarter "tickets," however, will be good for delivery through November, 1952; and fourth-quarter allotments will be good through February, 1953. Thus, nonmilitary allocations may "take it on the chin" until military orders catch up. One brighter note, however, is that civilian orders for third-quarter and earlier delivery will carry a priority over all fourth-quarter orders, including set-aside orders given to mills to protect fourth-quarter orders by military, atomic-energy and machine-tool buyers.

Decontrol of steel will be postponed about a year. Long-range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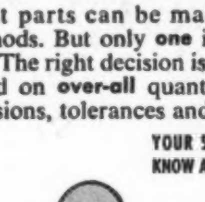

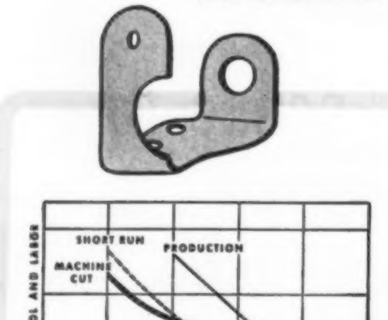

This logarithmic chart shows the effect of these factors on the **specific part** illustrated. From 1 to 65 parts, our own **Machine-Cut Method** with no die cost whatsoever is most economical. At 65 parts, the **Short-Run Method** using economical blanking dies and stock punches is best. At 7,000 units, the standard **Production Method** with standard dies is most satisfactory.

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impact of the strike may be felt even later, since all major programs for expansion of production facilities for other materials have been affected by the work stoppage. New construction for aluminum production, for example, will be delayed at least two months, possibly more.

Copper Climbs: Although much emphasis has been placed on aluminum as a substitute for copper, many people in the copper-producing industry have pointed out that the copper situation is not as drastic as fairly recent government recommendations have indicated. In many applications copper is irreplaceable as a heat-transfer medium or electric conductor. And the copper supply has eased recently, since prices on foreign copper have lowered.

Actually, copper is not in unusually short supply. Copper allocations for the third quarter were 120.1 per cent of supply, while aluminum allocations were 117 per cent—not a great difference. The recent decline in world copper prices indicates that U. S. manufacturers will be able to purchase the full amount of copper granted to them under recommendations of the International Materials Conference—a condition that was not true previously, because of the difference between the fixed domestic price and the higher cost of foreign copper.

In actual tonnage figures, fourth-quarter allocations are based on a supply estimate of 402,000 tons of refined copper, an increase of 57,000 tons over the original estimate, due to the new prices. So the immediate supply of copper seems to be adequate.

Taking a long-range viewpoint of the copper vs. aluminum situation, the odds seem to be more on the side of aluminum, since aluminum's possible and projected production expansion is far more than copper's. But, by the same token, this does not mean any reduction in the supply of copper available. Barring any radical changes in the supply and demand picture for copper, supplies will be adequate.

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Stress Relief

LAMPOONING engineering department personnel is not J. P. Henderson's sole stock in trade. At times he waxes constructive, though in a critical vein, on other issues. This month, in pursuing the cause of independent thought and action, he bases his commentary on the premise that a question is as revealing as a declaration.

Security or Stagnation?

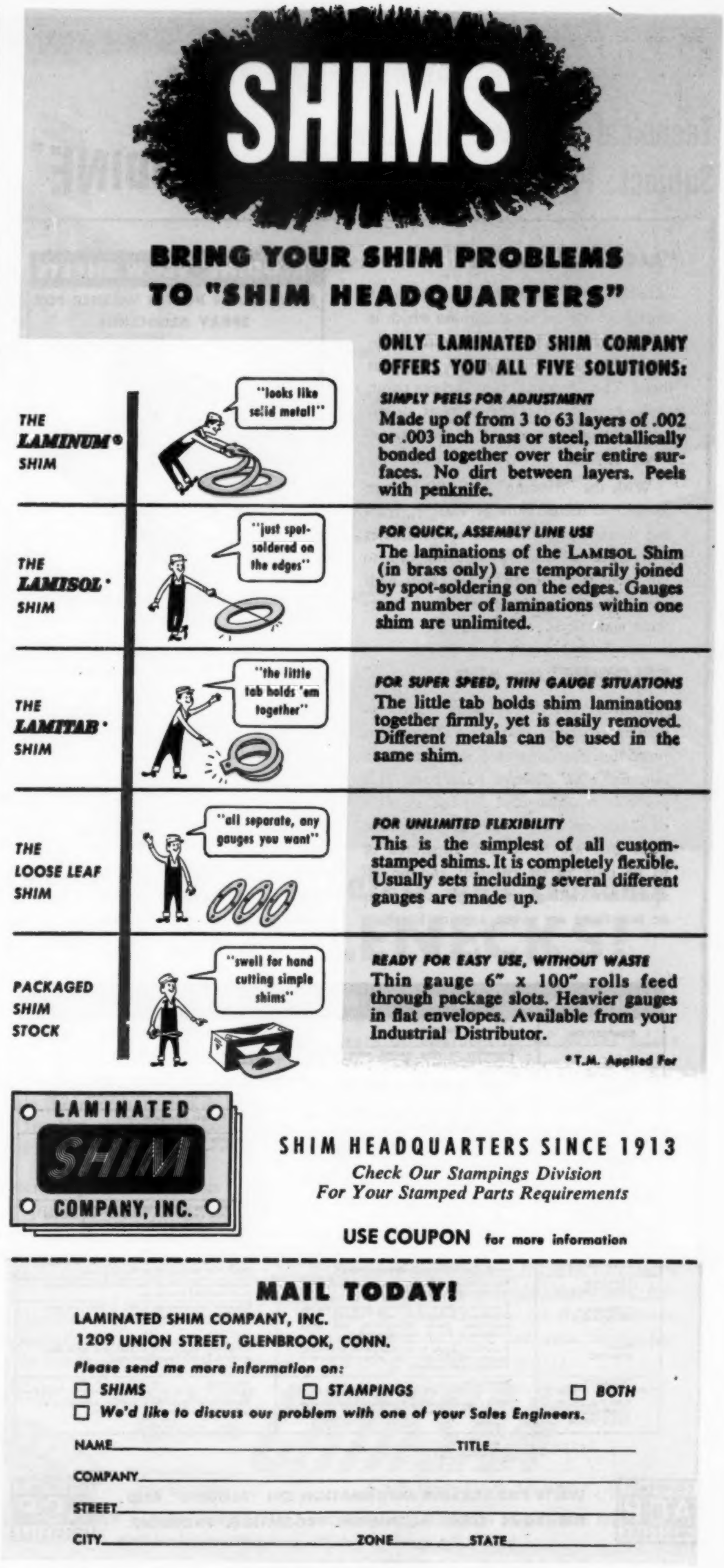
"What kind of a pension plan do you have?" More and more, young men just out of high school or college are asking this question when being interviewed for jobs. If it's a casual sort of question, it's natural enough. But if it carries great weight in the young man's decision, we're headed plumb for disaster!

We are all becoming security conscious, from the national to the personal level. But what is happening to us when men under 30 years of age are putting such emphasis here? Isn't there something odd about a college graduate who has barely cast his first vote and is interested in a pension plan?

I'm old-fashioned enough to think a kid like that should put *opportunity* first.

An Englishman by the name of Toynbee has written six volumes on *A Study of History*. Another historian, D. C. Somervell, has made a one-volume abridgement. It's a good book for any young man to know about.

The history of every primitive people, and the civilization which they did or did not develop are traced according to certain patterns of *challenge* and *response*. Faced with the challenge of harsh climatic conditions or external pressures, people developed a high level of civilization. Wandering into a lush land of easy living, they stagnated. With little challenge there was little response in the form of individual or national ingenuity. Make a quick comparison,



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Subject: PROTECTING ALUMINUM WITH ALODINE®

"ALODINE" No. 100

"Alodine" No. 100 forms an amorphous phosphate surface on aluminum which is thin, tough, durable, non-metallic, continuous with and a part of the basis metal. The "Alodine" film anchors paint, prolongs paint life, and protects aluminum exposed unpainted to the atmosphere.

With the "Alodine" No. 100 bath at its normal temperature of 120° F., coating time by immersion approximates 1½ minutes—and by spraying, 15 to 20 seconds. Coating times and bath temperatures can be varied to suit operating conditions.

"ALODINE" No. 600

"Alodine" No. 600 forms corrosion-resistant coatings that provide excellent protection for unpainted aluminum and also make an effective paint-base. This grade is recommended for use in place of "Alodine" No. 100 on aluminum parts that are to remain unpainted or to be only partly painted; and on *all* aluminum castings and forgings whether or not these are given a paint finish.

"ALODINE" FLOW SHEETS

MULTI-STAGE POWER WASHER FOR SPRAY ALODIZING

IMMERSION TANKS FOR DIP ALODIZING

PROCESS SEQUENCE
1. Clean 2. Rinse 3. "Alodine" 4. Rinse 5. Final Rinse

NOTE: Equipment can be of mild steel throughout, except the "Alodine" stage which must be of acid-resistant material.

"Alodine" No. 600 is applied at room temperature (70° to 120° F.). Recommended coating times are 3 to 5 minutes for an immersion process and 1 to 1½ minutes for a spray process.

COATING DATA	"ALODINE" NO. 100	"ALODINE" NO. 600
COMPOSITION	Amorphous phosphate.	Amorphous mixture of metal oxides and chromates.
COLOR	Depending on alloy treated, color range is from an iridescent blue-green to a dark slate gray.	Depending on time of treatment, color range is from golden iridescent to light brown.
THICKNESS	From 0.01 to 0.08 mil. No appreciable dimensional changes occur when aluminum is Alodized.	From 0.005 to 0.01 mil. No appreciable dimensional changes occur when aluminum is Alodized.
WEIGHT	50 to 300 mgs. per square foot. Optimum: 100 to 200 mgs. per square foot.	35 to 50 mgs. per square foot.
SOLUBILITY	Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis. However, strong acids and alkalis which attack aluminum may penetrate the "Alodine" film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate, etc.	Insoluble in alcohol, water, solvents, etc. Soluble in strong alkalis and acids.
ELECTRICAL PROPERTIES	High dielectrical resistance.	This coating is electrically conductive. Aluminum coated with "Alodine" No. 600 can be shielded-arc welded or spot welded.
HEAT STABILITY	Unimpaired at temperatures that melt aluminum.	Unimpaired at temperatures that melt aluminum
FLEXIBILITY	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.
ABRASION RESISTANCE	Approximately 90% of that provided by chromic acid anodized aluminum.	Approximately 90% of that provided by chromic acid anodized aluminum.
CORROSION RESISTANCE	Painted—superior to chromic acid anodizing. Unpainted—comparable with chromic acid anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Exceeds requirements of MIL-C-5541 and even AN-QQ-A-696a (anodic films)
PAINT-BONDING	Excellent. Equal to or superior to anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Excellent. Meets MIL-C-5541 and other Government Finish Specifications.
TOXICITY	Non-toxic.	Non-toxic.
BIMETALLIC CORROSION RESISTANCE	Shows good resistance against bimetallic or galvanic corrosion.	Shows good resistance against bimetallic or galvanic corrosion.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "ALODINE" AND ON YOUR OWN ALUMINUM PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

for instance, of the Dutch and Scandinavians with the South Sea Islanders.

A generation or two of Americans whose primary interest is in *security* should make this a widely different nation from the one formed by our rifle-toting, westward-facing ancestors.

I've interviewed young men who asked about pensions and job security. In my mind's eye, I see such a fellow buying a house, getting into a rut in his work, and possibly getting passed over for promotion. But he stays on. After all, he owns his home, his friendships are established, and taking a new job involves a considerable gamble. He never presents a challenge to the boss either, to keep him satisfied or to hold him.

As an employer, I was content at times to get a man who would develop into a faithful old nag. He might do more than his share of the routine horse work!

But as a person, with kids of my own, I feel a little differently towards him. Unless he's exceptionally fortunate, he should never be using our pension plan at all. Sometimes a young man can go farthest by taking this attitude toward his employer: "You'll never *own* me. So long as my work is reasonably interesting and I see some chance of getting ahead, I'll give it all I have. But when the future looks too uncertain or hopeless, I'm taking a new job—3000 miles away, if need be."

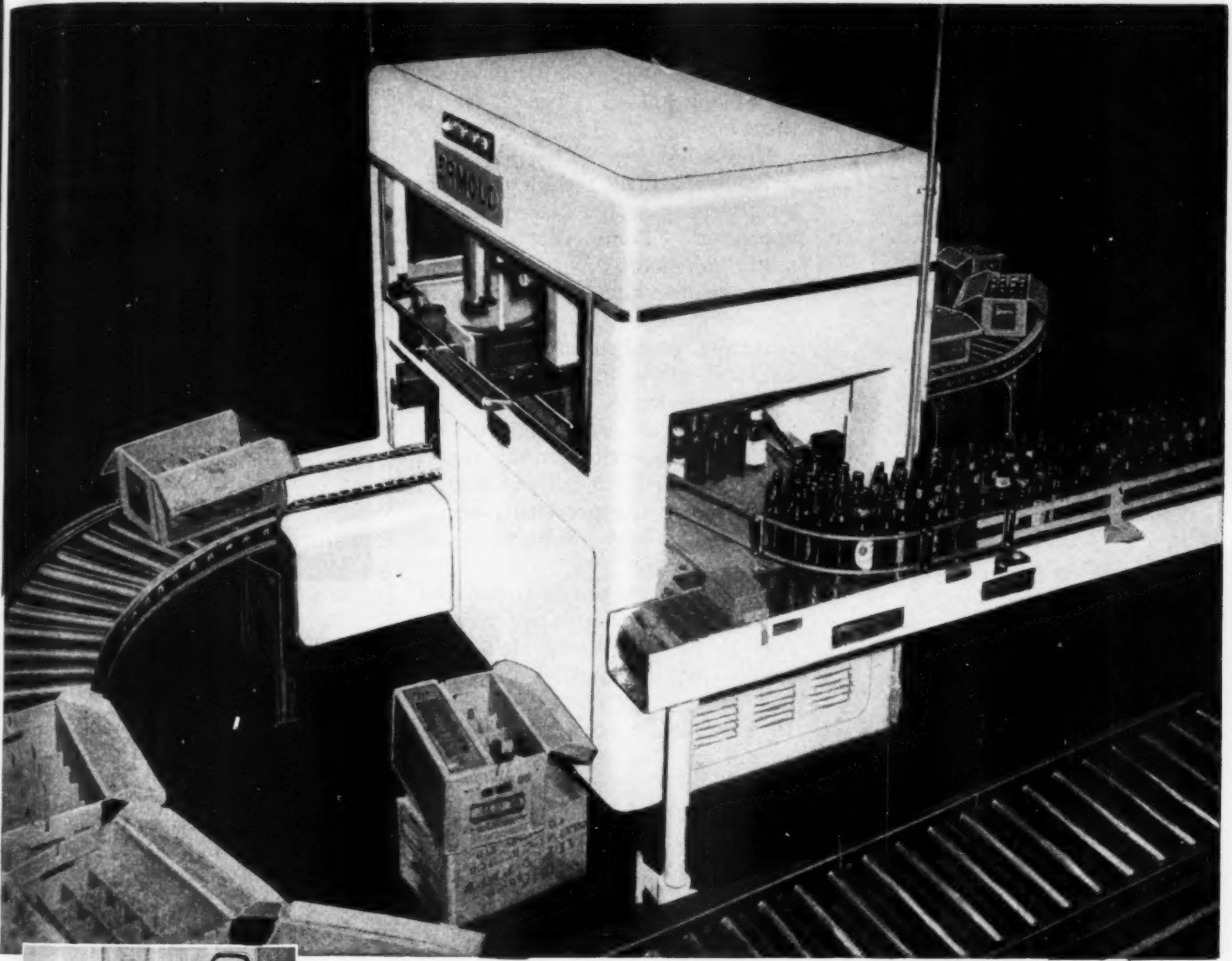
He doesn't have to say this to the boss; in fact, he shouldn't. But in the long run, the boss can sense it. Here is a man whose idea of "security" is to be able to face any situation, rather than lean against the walls of his rut.

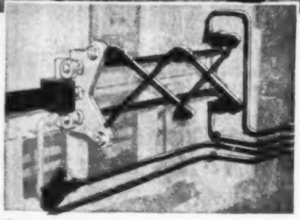
—J. P. HENDERSON

J. P. is prolific both in the volume of his correspondence and the directions it takes. This month he comes through with a dividend—an extra contribution to increased engineering department efficiency.

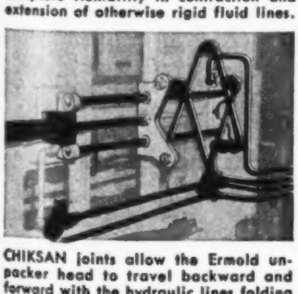
Looking Out for Imogene

There seems to be a national week devoted to almost anything





CHIKSAN aircraft hydraulic swivel joints employed in this application permit complete flexibility in contraction and extension of otherwise rigid fluid lines.



CHIKSAN joints allow the Ermold unpacker head to travel backward and forward with the hydraulic lines folding and unfolding automatically.

CHIKSAN aircraft swivel joints enable Ermold to make sharp bends in the hydraulic lines as the mechanism moves forward and backward in the unloading operation illustrated above.

CHIKSAN Flexibility, Safety and Economy

END BOTTLENECKS!

When the Ermold Division of The Barry-Wehmiller Machinery Company decided to put out an improved automatic unpacker, it just naturally turned to Chiksan Ball-Bearing Swivel Joints to provide the necessary flexibility and stamina for the electrically-controlled hydraulic system.

This system imparts the motion for precision stopping and starting—for raising and lowering elevating mechanism—for gripping firmly and delicately the most fragile material.

This application is just another example of how industry relies on Chiksan's mastery in the flow of liquid and gas—around seemingly impossible joints and angles—and through unyielding metal. Years of engineering of swivel joints have taught Chiksan how to gain precision, achieve incredibly close tolerances, provide higher resistance to extremes of temperature and pressure. *Whether you're a bottler, a chemical processor—engaged in heavy industry, transportation or the petroleum industry, Chiksan Ball-Bearing Swivel Joints can help do a better job for yourself—for your customers—for less. Chiksan's Department of Development and Research stands ready to put its experience and skill to work for you. Write for Catalog 2A, Dept.* 9-*MD.*

The Flow of Enterprise Relies on **CHIKSAN**

Ball-Bearing Swivel Joints

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shows up best where the frictional conditions are difficult

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MD9 MS-9

Stress Relief

or anyone. Why not a "Be Kind to Stenographers Week"? Or is there?

Here's how.

There's a little technique on report writing which few engineers appreciate. Some short reports might be dictated, of course, but it is assumed that the average engineering report is written out longhand, polished off in the process and given to the typist for copies to be made.

Ask the average engineer for whom he is writing that report and he is likely to tell you it's for his boss, or the president, or the sales dapartment or who have you. But he's wrong.

He's writing the report for Imogine, the typist; she will write it for the president, etc. He'd get a better looking report and more cheerful service if he'd remember that simple fact. And the engineer more than most other people *should* remember it. His reports are frequently full of symbols, including the Greek. And no matter how experienced the typist may be many of his data remain Greek to her.

Given copy to type in a blurred mile-a-minute handwriting, if she reads "He will contact you before the blur of our next meeting" she can use her ingenuity and reading glass and decide you meant to write "date." But if the blur turned out to be a Greek sigma in a complicated technical sentence, she's likely to stop there, decide she needs a cup of coffee and then approach you for an explanation.

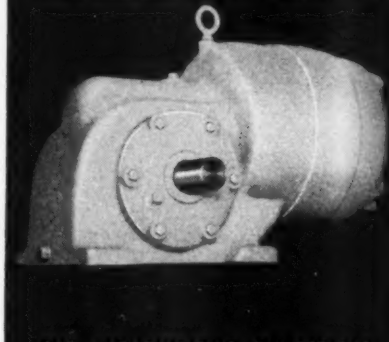
The better technique is comparatively simple once you get into the habit of it. Write the report for the typist like this:

and further tests indicate that the angle θ (Imogene, that's Greek—fill in carefully with ink) is equal to θ_h (Imogene, that h is sub).

It's usually the engineer's figures that bother the typist the most. But then, just to show how things often equalize in this best of all possible worlds, it's usually the typist's figure that bothers the engineers, too.

—J. P. HENDERSON

ELECTRA



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WRITE FOR BULLETIN 400
WHICH GIVES BASIC ENGINEERING DATA

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Meetings

AND EXPOSITIONS

Sept. 11-14—

Packaging Machinery Manufa turers Institute, 20th annual mee ing to be held at the Homestea Hot Spring, Va. Additional i formation may be obtained fro society headquarters, 342 Madiso Ave., New York 17, N. Y.

Sept. 22-23—

Steel Founders' Society. Fa meeting to be held at the Home stead, Hot Springs, Va. Addition al information may be obtaine from society headquarters, 92 Midland Bldg., Cleveland, Ohio.

Sept. 22-24—

American Society of Mechanica Engineers. Petroleum mechanica engineering conference to be hel at Hotel President, Kansas City Mo. C. E. Davies, 29 West 39t St., New York 18, N. Y., is sec retary.

Sept. 29-Oct. 1—

National Electronics Conference Eighth annual conference to b held at the Sherman Hotel, Chi cago, Ill. under the sponsorship o the American Institute of Electri cal Engineers, the Institute of Ra dio Engineers, Illinois Institute o Technology, Northwestern Univer sity, and the University of Illinois with participation by Purdue Uni versity, University of Wisconsin and the Society of Motion Picture & Television Engineers. Addition al information may be obtained from S. R. Collis, Chairman, N.E.C. Publicity Committee, 208 West Washington St., Chicago, Ill.

Sept. 30-Oct. 3—

Association of Iron and Steel Engineers. Annual convention to be held concurrently with the four-day exposition at Cleveland Public Auditorium. Mr. T. J. Ess, 1010 Empire Bldg., Pittsburgh 22, Pa., is managing director.

Oct. 1-3—

National Association of Corrosion Engineers. South central re-

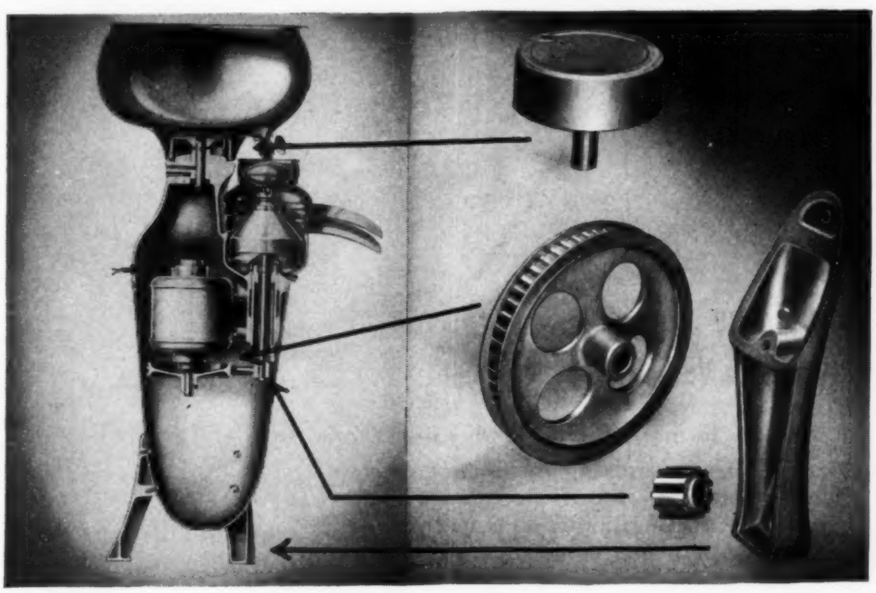
get the mo$t for your Zinc Die Ca$ting Dollar!

SPECIAL HIGH GRADE ZINC
—the grade used in
die casting alloys—
IS NOW IN AMPLE SUPPLY

STREAMLINE THE DESIGN

Today's competitive selling calls for advanced styling—whether the product be one for factory, farm or home. Consider the product pictured below—the latest addition to the De Laval line of cream separators. It is completely streamlined for maximum appeal to the 1952 farm family—a far cry from the separator that you remember from your boyhood farm visits.

There is more to the advanced styling of this product than meets the eye. It has been redesigned *inside* and *out* to achieve maximum quality at minimum cost and, as with countless other products, this goal has led to the use of ZINC Die Cast components. The tooth-type motor and spindle pulleys, the collar which supports the supply can and the three legs of the new centrifugal separator were designed by De Laval engineers to get the most for their ZINC Die Casting Dollar!



MINIMIZE ASSEMBLY

Each of the ZINC Die Castings pictured above is designed to reduce both machining and assembly operations. The teeth on the two pulleys are integrally cast with a high degree of dimensional accuracy for quiet, efficient operation with a corrugated belt. Only simple broaching operations are required on these pulleys and the one-piece construction minimizes assembly time—and cost. The supply can supporting casting also reduces assembly, since the steel shaft is cast as an insert.

All unnecessary metal has been eliminated in the design of these die castings. The leg casting, for example, has a massive outward appearance but, actually, it is cored in the casting operation to reduce to a minimum the amount of metal consumed. ZINC Die Castings are inherently tough and do not require excessively heavy sections to meet strength requirements.

ASK FOR DESIGN HELP

The surest way to realize the full physical and economic advantages of ZINC Die Castings is through consultation with a competent die casting engineer in the *early* design stages. Any die casting company will welcome the opportunity to be of service. Also ask that company for a copy of "Designing For Die Casting"—or write to us.

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160 Front St., New York 38, N. Y.

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FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
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Model AP3V Variable Volume

Faster, farther, higher, and safer . . .

As new records are set almost daily in every phase of aircraft performance, more and more responsibility falls to those who make operating components for these planes. Additional power, speed, precision, control and dependability must be built into smaller and lighter-weight units wherever possible.

The aircraft pump shown above is an example of how, through intensified research, Denison's long, specialized experience in hydraulics is applied to the job of keeping ahead of these ever-growing demands. This 3000 psi, compensator controlled pump, rated at 3 gpm at 1500 rpm, features excellent suction characteristics . . . extremely high over-all efficiency . . . and rugged, compact dependability that simplifies the designer's problems.

We are interested in any opportunity to help with your requirements for high pressure aircraft pumps and pressure controls. We will gladly send you complete specifications upon request. Also, if one of our specially qualified engineers can be of help to you, just let us know. Write today.

Other Denison aircraft components for circuit needs up to 5000 psi include Constant Volume Pumps . . . Relief Valves . . . and Surge Damping Valves that prevent damaging pressure shock.

DENISON HydrOILics

The DENISON Engineering Co. 1156 Dublin Road Columbus 16, Ohio

gional meeting to be held at the Jung Hotel, New Orleans, La. Additional information may be obtained from society headquarters, 1061 M & M Bldg., Houston 2, Texas.

Oct. 1-4—
Society of Automotive Engineers. Aeronautic, aircraft engineering display and production forum to be held at Hotel Statler, Los Angeles, Calif. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary.

Oct. 10—
National Noise Abatement Symposium. Third annual symposium to be held at the Armour Research Foundation of Illinois Institute of Technology. Daniel B. Callaway, Illinois Institute of Technology, Technology Center, Chicago 16, Ill., is chairman.

Oct. 16-17—
Gray Iron Founders' Society. Annual meeting to be held at Hotel Cleveland, Cleveland, Ohio. Additional information may be obtained from society headquarters, National City Bank Bldg., Cleveland 14, Ohio.

Oct. 16-18—
Foundry Equipment Manufacturers Association. Annual meeting to be held at the Greenbrier Hotel, White Sulphur Springs, W. Va. Additional information may be obtained from society headquarters, 1213 West 3rd St., Cleveland 13, Ohio.

Oct. 20-24—
American Society for Metals. National metal exposition and congress to be held at the Philadelphia Convention Hall, Philadelphia, Pa. W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio, is national secretary.

Oct. 22-24—
Society of Automotive Engineers. Transportation meeting to be held at the William Penn Hotel, Pittsburgh, Pa. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary.

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PUMP/MOTOR

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MOTOR

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For *continuous duty* at 2000 psi

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Where there's a fluid motor, there's a hydraulic pump — and there's a Denison PUMP/MOTOR model for low-cost efficiency on either job!

Every PUMP/MOTOR is ready for use as either pump or motor *without alterations of any kind.* They are easily converted for clockwise or counter-clockwise rotation. Opposed inlet and outlet porting assures complete radial hydraulic balance of the rotor — resulting in minimum surge and pulsation, with less wear on all moving parts. Radially balanced vanes contact the cam ring with dual sealing edges — low loading characteristics are retained at all operating pressures.

PUMP/MOTORS are made in four sizes, with interchangeable cam rings to widen the range of capacity levels in each size. As pumps, their capacities range from 2.7 to 70 gpm at 2000 psi. As motors, torque capacities range from 13 to 257 pound-inches per 100 psi. PUMP/MOTORS are rugged and compact . . . built for long life under hard, continuous use at 2000 psi . . . they give you *more value per pound* than any vane pump or motor on the market!

Write for Bulletin P-5 today!

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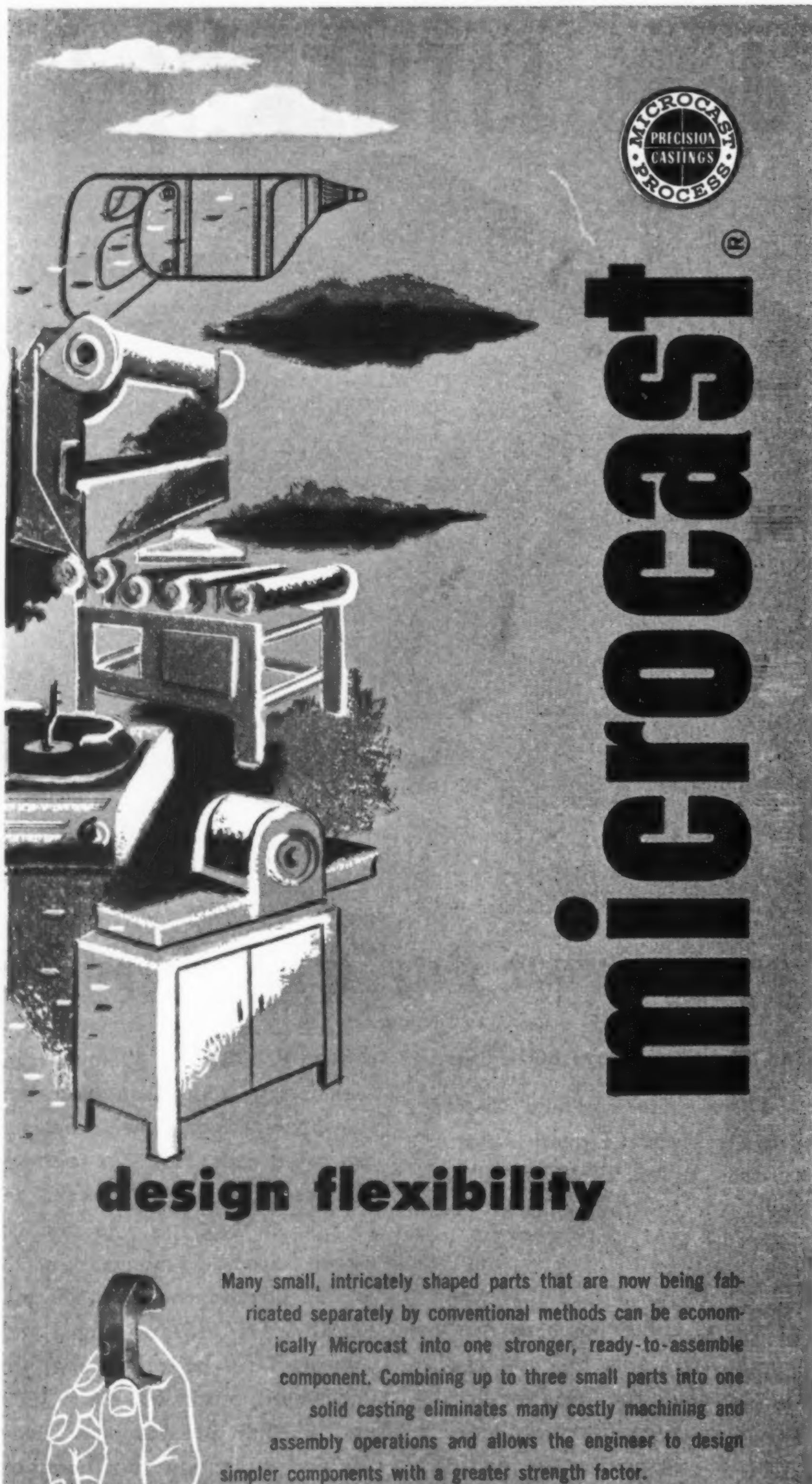

Design Abstracts

(*Continued from Page* 185)

when ω approaches the value zero, the value K, by definition invariant with frequency, is left. Servomechanism theory assumes K to be constant, giving a linear output. This assumption can not always be made in designing a measuring or control system, since linearity may be a prime objective.

Applications: Some examples will be useful in demonstrating this approach. The first system to be analyzed is a fluid pressure to pneumatic pressure transducer. It is desired that this device transmit a pneumatic output pressure signal which is proportional to an input fluid pressure. A schematic line diagram of the device is shown in *Fig. 2a*. In this device, a reference input pressure P_1 supplied to a bourdon tube produces a displacement S_1, which moves the flapper towards the nozzle. This movement tends to restrict the flow of air from the nozzle, which is supplied through a restriction, creating a build-up of pressure in back of the nozzle. The nozzle pressure P_N is fed into a pilot relay valve which amplifies the pressure by a constant gain factor G_P. The output of the pilot valve is the output pressure P_O from the overall device. This pressure P_O is fed back into the bellows, where it acts on an effective area A_B and against the stiffness, k_B, of the bellows spring to produce a displacement. The displacement of the bellows actuates a lever to which the nozzle is attached, causing the nozzle to retreat from the flapper. Thus, the output pressure will be built up in proportion to the reference input pressure.

In order to provide a well organized analysis, all deflections, lengths, areas, forces, pressures, deflection gradients and other physical parameters in the device are listed and defined in TABLE 1. Beginning with the simplifying assumption of rigidity for all members for which flexibility is not considered essential to the proper functioning of the system and fol-

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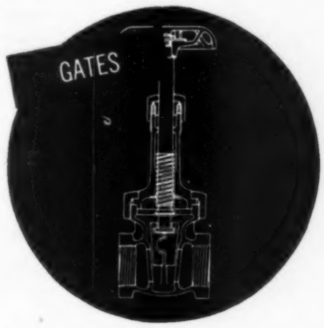

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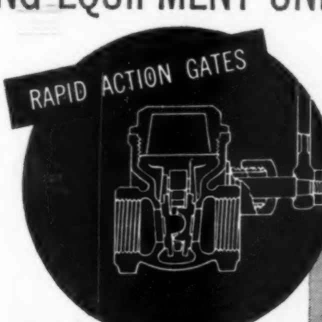
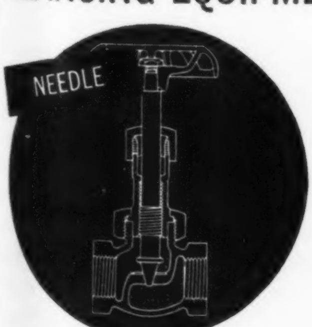


CLEANSING EQUIPMENT • HEATING UNITS



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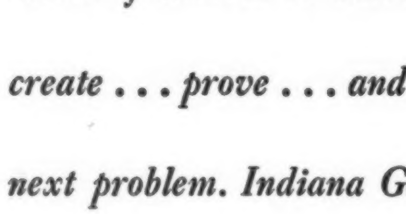

INDIANA GEAR

The driven gear shown here is 5" in pitch diameter and 15" long overall. It is carburized and hardened with heat-treating distortion held within .001".

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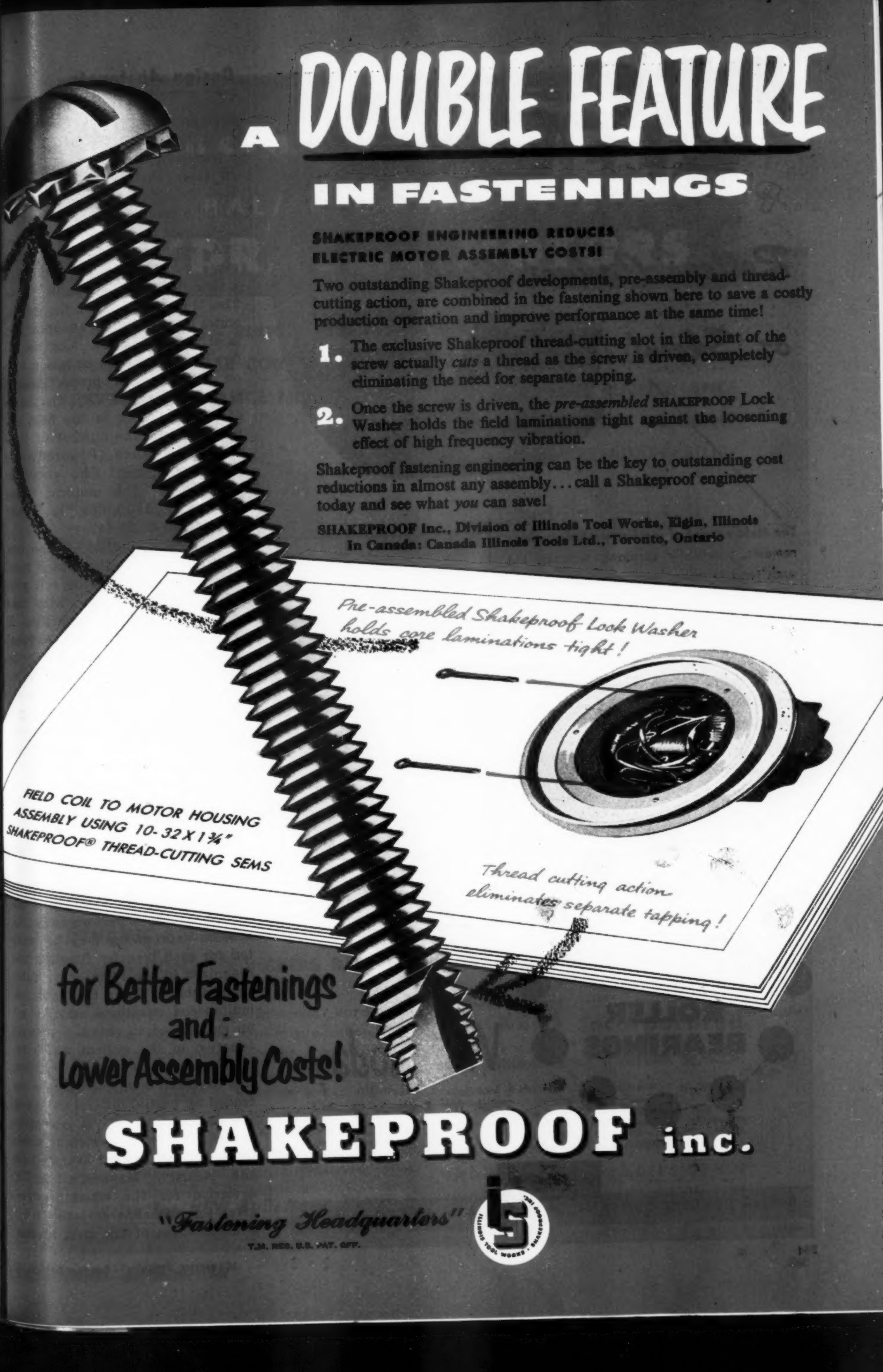
lowing the symbolism of *Fig.* 1, the block diagram of the pressure-to-pressure transducer can be made as shown in *Fig. 2b*.

At the upper left-hand corner of the diagram, the input pressure P_1 is converted by the bourdon tube into the displacement S_1 shown coming into a summation circle. Output from the summation circle, S_A, the actuating displacement, is shown as the difference between S_1 and S_F, the feedback displacement. The actuating displacement S_A is measured as the relative displacement between the flapper and nozzle. Shortening this distance builds up the nozzle pressure P_N in accordance with the flapper-nozzle characteristic N_N. Thus, a conversion of S_A into P_N may be shown by means of the flapper-nozzle curve slope N_N. Nozzle pressure P_N is converted into the output pressure P_O by means of a relay pilot valve of gain G_P. Output pressure P_O acting on area A_B, the effective area of the bellows, produces a force F_B, which in turn is converted into a bellows displacement S_B by means of the factor $1/K_B$, where K_B is the bellows deflection gradient. S_B is converted into the primary feedback displacement S_F by means of the lever ratio R.

Amplifier Circuit

Another example of block analysis is provided by the simple amplifier circuit shown in *Fig. 3a*. An actuating voltage E_A, which is the difference between an input voltage E_I and a feedback voltage E_F, is fed into an amplifier tube of gain μ to produce an output voltage E_O. The feedback voltage E_F is a portion β of the output voltage E_O.

The block diagram of the amplifier, *Fig. 3b*, clearly shows these relationships. A comparison of the block diagram, *Fig. 2b*, of the pressure-to-pressure transducer with the block diagram, *Fig. 3b*, of the amplifier, shows the fundamental similarity of the two devices. The similarity is deeper than a mere analogy; there is an identity of function of the different parts of the circuits. In each there is a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1. The exclusive Shakeproof thread-cutting slot in the point of the screw actually *cuts* a thread as the screw is driven, completely eliminating the need for separate tapping.
2. Once the screw is driven, the *pre-assembled* SHAKEPROOF Lock Washer holds the field laminations tight against the loosening effect of high frequency vibration.
Shakeproof fastening engineering can be the key to outstanding cost reductions in almost any assembly... call a Shakeproof engineer today and see what *you* can save!
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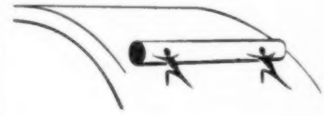
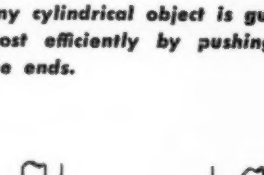
PITCHLIGN bearings are dimensionally interchangeable with precision needle bearings. Get all the facts!



Any cylindrical object is guided most efficiently by pushing at the ends.



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high-gain element in the forward or upper part of the loop. In each a portion of the output is subtracted from the input after having been transformed into the same units through the feedback or lower part of the loop.

A simple galvanometer which gives a deflection proportional to a current is represented in *Fig. 4a*. The block diagram of the system, which is seen to be an open loop, is shown in *Fig. 4b*. Current (I) flowing in the coils causes a force on the conductor proportional to the magnetic field (B), the length of one conductor in the field (L) per turn, and the number of turns (N). This force (F) produces a torque or moment (M) about the pivot point. This moment causes the spiral hairspring to deflect through an angle (θ).

From an inspection of the first block, it may be seen that B must be constant, both as the coil position changes, and also with time and temperature. Quantities N and L are fixed by the physical size of the coil. Also, it may be seen the galvanometer calibration depends on the hairspring constant (K). Thus, by breaking the galvanometer up into its fundamental conversions, better visualization and analysis of the theory of operation is permitted.

Performance Equations

In addition to providing a means for reducing devices to their fundamental conversions, block diagrams can be used very effectively to obtain equations of performance. Algebraic expressions may be written for each transfer function and organized in the form of a "functional table." From this table, simultaneous equations may be set up and solved to obtain a general equation of the system which relates output to input. Further, this algebraic analysis may be extended by partial differentiation to determine what gain is necessary at each part of the system in order to obtain any desired overall gain and linearity. Maximum possible deviation for the whole system, given the maximum deviation from a mean value of the gain in per-

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(At Right) Series 500 Vickers Hydraulic Motors available in two sizes with flange or foot mounting.

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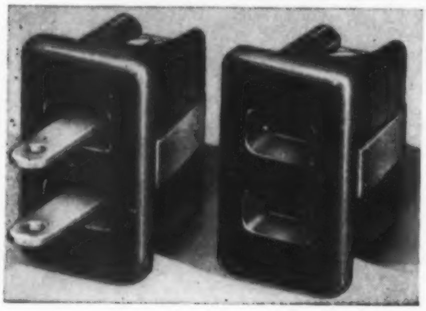

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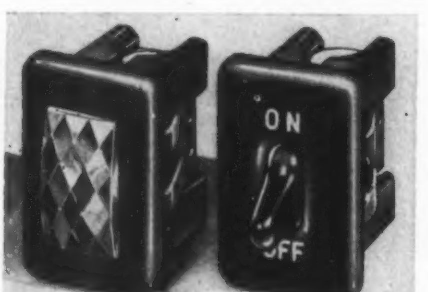

***Save Man Hours** — toggle switches, pilot lights, convenience outlets and interconnecting load plugs just snap into their holes. Wire them up before or after. Spring clips hold them firmly and permanently. Wide flanges eliminate need for exacting tolerances in finish around installation holes.

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Switches, both single and double pole, have contacts held together under positive spring action in "on" position. Rated 12 and 20 A. 125 V; 10 A, 250 V., A. C., and also available with horsepower ratings. Pilots, rated 115 V or 230 V, A. C., have large faceted lenses to give greatest light output of any comparable pilots on the market. All available in black, white, brown or special color plastic.

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cent for each system component, may also be calculated.

The organizational value of a block diagram may easily be seen where the design of the device involves simultaneous work on components by several groups. Using cards containing concise information on the component factors previously discussed, the day-to-day progress toward the overall design objectives can be quickly assessed.

From a paper entitled "A Systematic Design Approach Using Block Diagram Analysis" presented at the Semiannual Meeting of the ASME in Cincinnati, O., June 1952.

Carbide Developments

By J. S. Gillespie
and I. L. Wallace

Carboloy Dept.
General Electric Co.
Detroit, Mich.

NEW grades of cemented carbides are being developed when an application requires an unusual combination of physical properties such as in the armor piercing projectile. In this projectile, the armor piercing core is made of tungsten carbide. There are more and more mechanical or machine part applications all the time—such as bearings for high speeds and high loads, machine cams, and feed rolls. There are domestic applications such as paint scrapers, knife sharpeners, and masonry drills. There are medical applications such as dental burs.

Even with this tremendous, growing field, carbide engineers aren't satisfied with just cemented tungsten carbides. They are developing new families of carbides with new combinations of physical properties. One of these families is cemented chrome carbide. This material is available (still in limited quantities) in one particular grade with a chemical analysis of:

Chrome carbide—83 per cent
Tungsten carbide—2 per cent
Nickel—15 per cent.

Note that little tungsten and no cobalt are used. This carbide has

METAL TOO THIN TO THREAD ?

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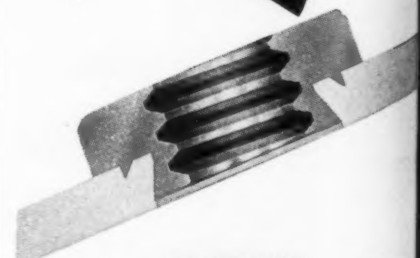

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More than 600 leading manufacturers have standardized on PEM self-clinching fasteners for good reasons—

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Write for literature and samples for trial. Use PEM self-clinching fasteners for fast assembly and lower costs. Penn Engineering & Manufacturing Corp., Doylestown, Pa.

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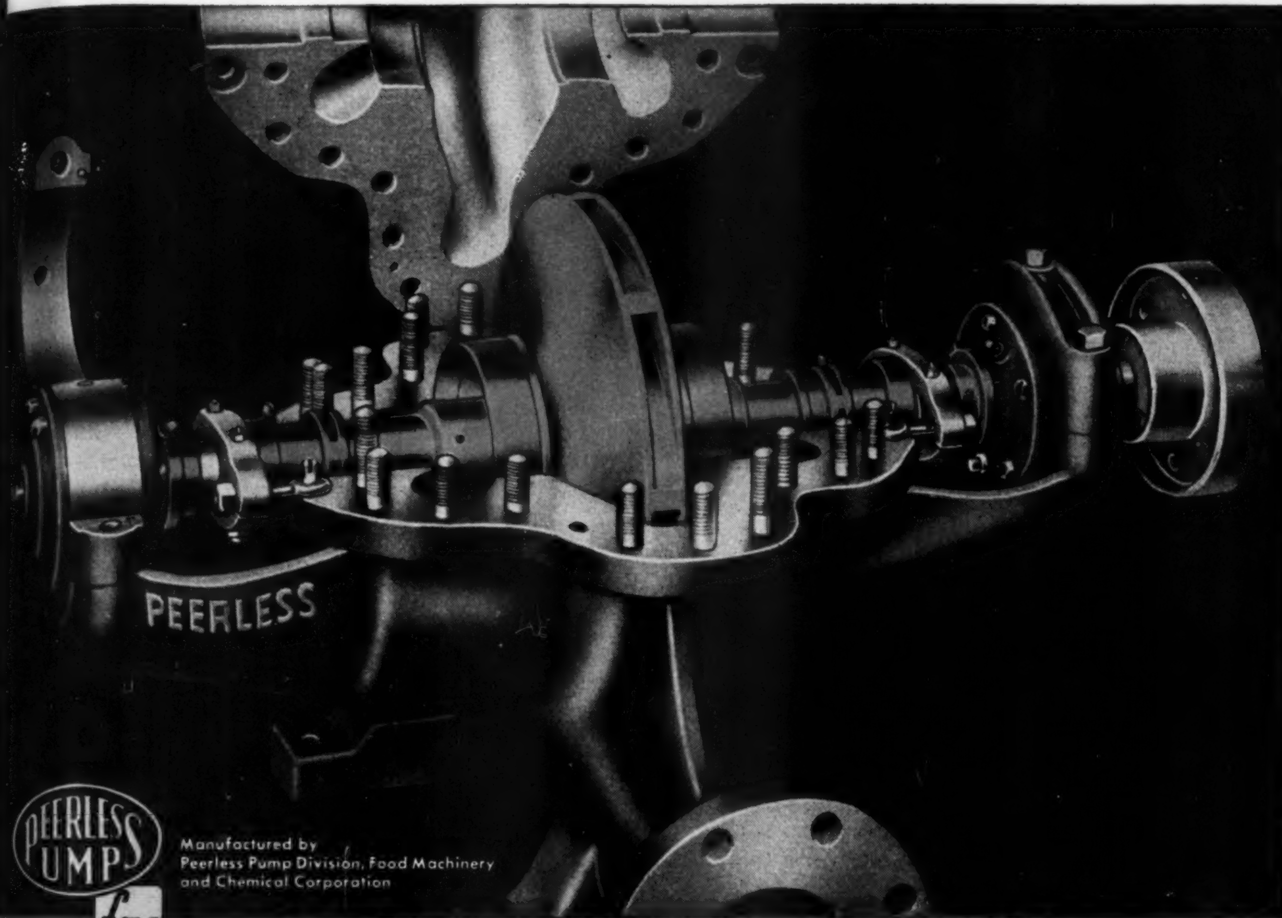

fmc

When fire strikes IT PUMPS PROTECTION

This is the heart of reliable systems that protect against hazards of fire

America's annual loss to the ravages of fire is a staggering amount. Reliable plant and property protection often begins with an independent fire protection system, the heart of which is an approved and reliable fire pump. In the manufacture of fire pumps, rigid construction requirements and operational dependability are paramount. This is why National Bearing Division was selected to supply bronze impellers, wearing rings, and shaft sleeves, for this fire pump and other pumps bearing the Peerless name.

In supplying component fire pump parts to Peerless, a supplier must not only meet the rigid requirements of this manufacturer, but also the strict regulations of Underwriters' Laboratories, Inc.; National Board of Fire Underwriters, Chicago; and the Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston.

National Bearing's proved ability to mass produce exceptionally fine-grained, non-ferrous castings, free from blow holes and sand inclusions, combined with Peerless Pump Division's exacting engineering and manufacturing standards help build fire pumps, and industrial pumps that can be counted to pump a reliable water supply for fire protection or other plant needs.

If your product requires non-ferrous castings or bearings, National Bearing Division has the foundry facilities, experience and skill that will insure better product performance and may possibly lower product costs.

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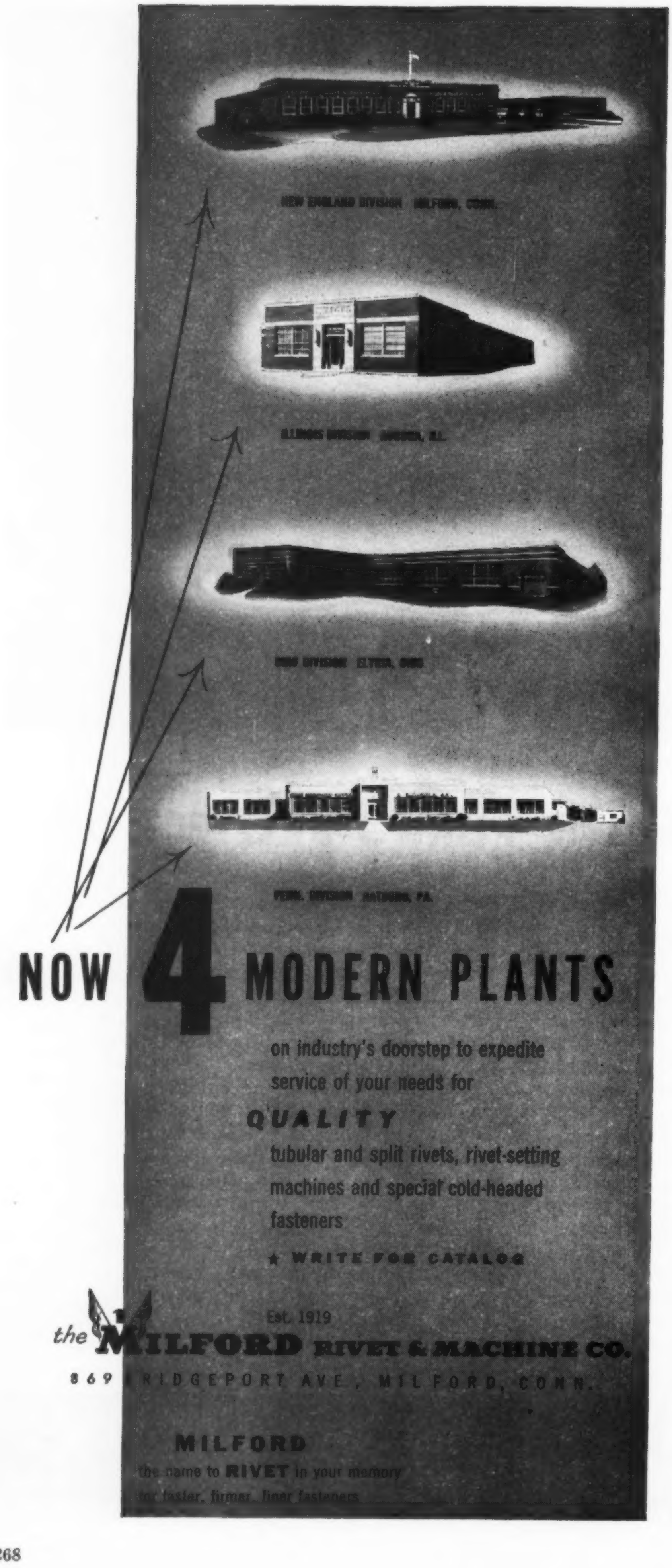


the following physical propertie

1. Hardness—88 Rockwell A
2. Density—7.0 gm per cu cm (slightly lighter than SAE-1095)
3. Transverse rupture strength—100,000 psi
4. Compressive strength — Higher than most hardened steels
5. Coefficient of thermal expansion—6.4×10^{-6} in the range of 70-1292 F
6. Abrasion resistance — Good; somewhat less than tungsten carbide but much better than hardened steels.
7. Resistance to oxidation—Only a slight surface discoloration after 24 hours in air at 1800 F
8. Resistance to corrosion — Excellent
9. Magnetic permeability — Nonmagnetic.

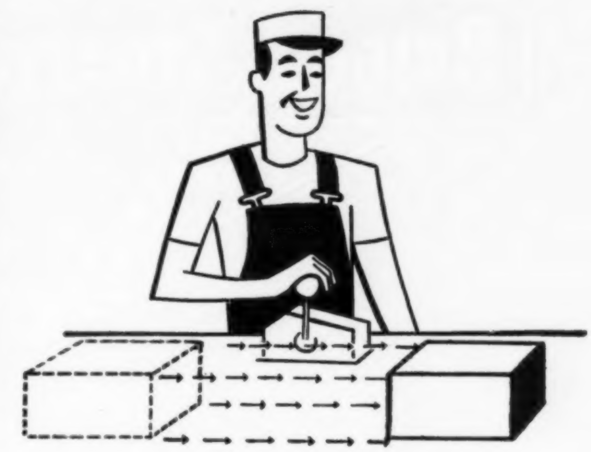
Chrome carbide is being used o numerous applications where it high hardness, corrosion resistanc and heat resistance make it bette suited than any other material. Fo gage blocks, cemented chrome car bide is proving superior to stee and tungsten carbide because of it good wear or abrasion resistanc light weight and a coefficient o thermal expansion that very near ly matches that of steel.

In the petroleum industry, valve that handle crude oil utilize chrom carbide to withstand the corrosiv attack of the acids and the brin in the oil. These valves must als resist the abrasion of sand an grit, and at the same time be long lasting because it is expensive t pull a valve from the bottom of well.

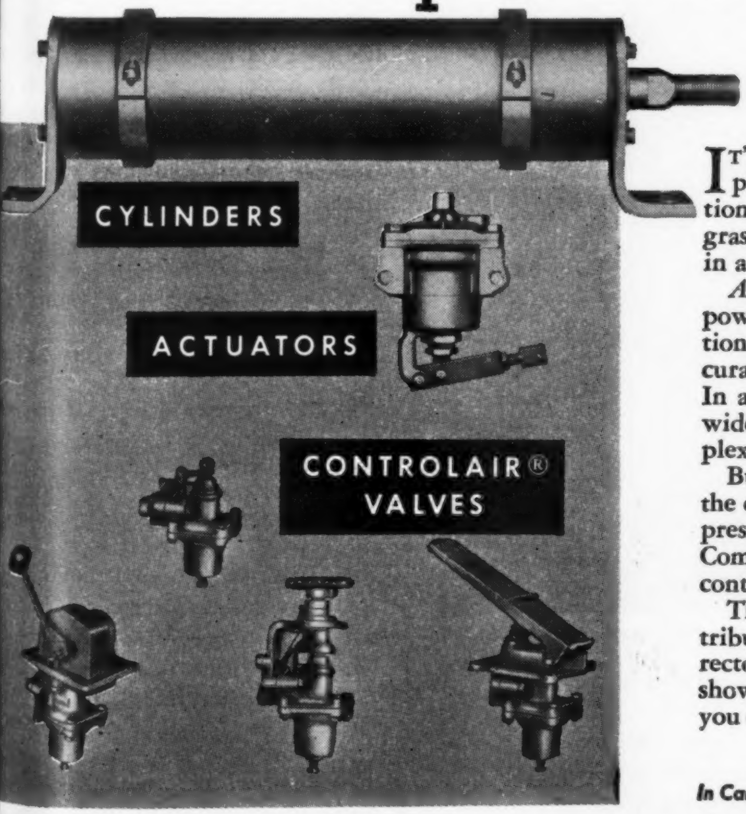
Another family of carbides th is being developed extensively an that shows lots of promise is titan ium carbides. These materials sho excellent rupture strength and oxi dation resistance at high tempera tures and in general, are resistan to thermal shock. In addition, the are light in weight, have goo abrasion resistance, and have hig compressive strength. This famil of carbides is being developed a present primarily for jet engine ap plications.

From a paper entitled "New De velopments in Cemented Carbides

want to clamp something ...or position it?



use these
low cost pneumatic muscles



It's hard to find a machine that doesn't require powerful, linear motion in some part of its operation. Clutches must be engaged, objects must be grasped and held fast, heavy loads have to be moved in a straight line.

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But the best part is this: you can buy everything, the cylinders, actuators, control valves *and* the compressor from one company, Westinghouse Air Brake Company, world leader in engineered pneumatic control systems.

There's a Westinghouse Air Brake Company distributor near you; just look in your Classified Directory under "Air Compressors." He'll be glad to show you how Westinghouse components can help you engineer a better product.

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presented at the Twentieth Annual Meeting of the ASTE in Chicago, Ill.; March, 1952.

Machining High Temperature Alloys

By P. G. DeHuff and D. C. Goldberg

Aviation Gas Turbine Div.
Westinghouse Electric Corp.
Pittsburgh, Pa.

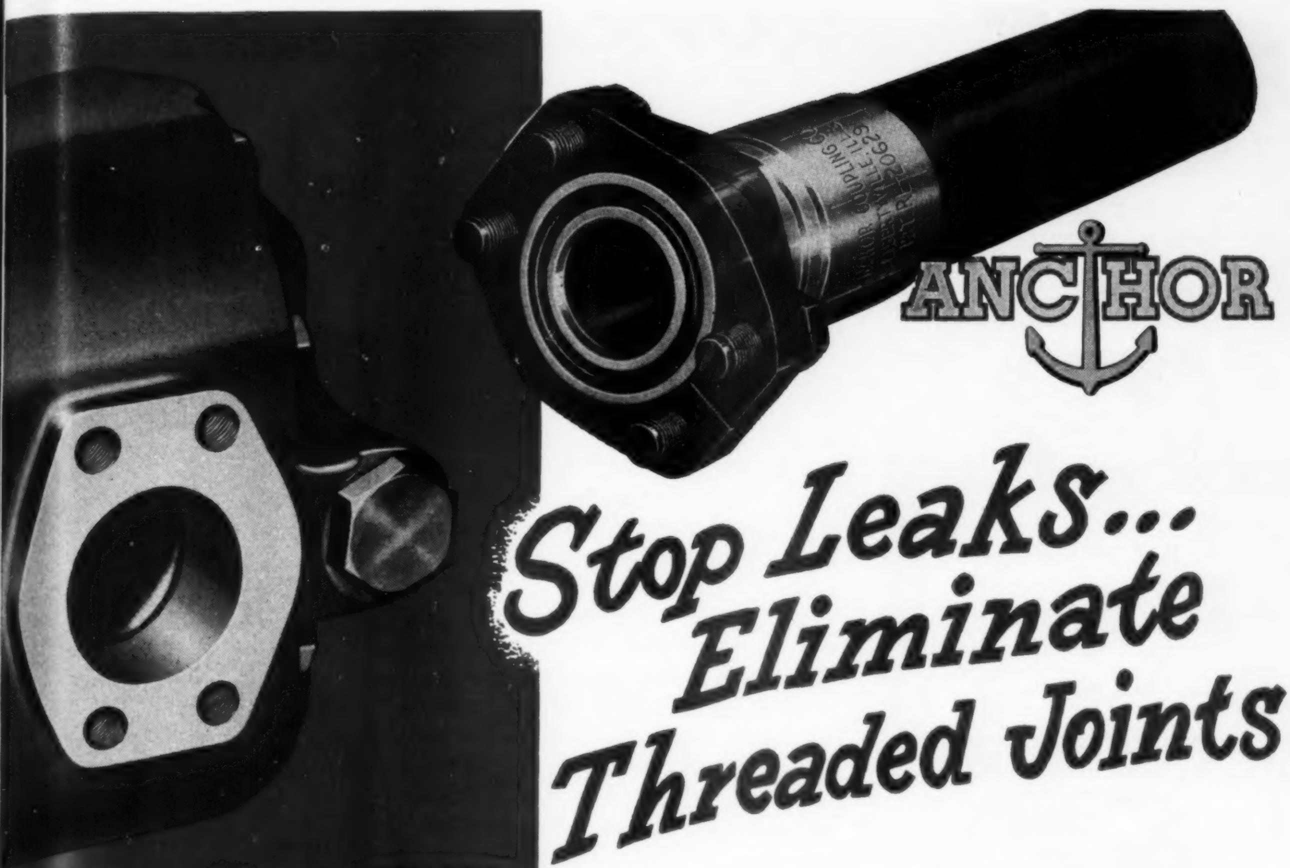
IN THE machining of the high-temperature alloys, as with other steels, the optimum aim is long tool life, rapid removal of metal, low power input, and satisfactory surface finish. It is readily seen that in roughing operations the chief goal is to remove metal as rapidly as is economically possible, while in finishing, the attainment of the desired microinch finish and accurate contour are required.

To achieve these goals, it is necessary to consider the following seven basic factors, variations in any one of which will have an immediate effect on the production rate and the quality of the completed part:

1. Inherent machinability of the alloy
2. Design of the part being fabricated
3. Design and type of the cutting tool
4. Capacity and rigidity of the machine tool
5. Accessory tooling
6. Feeds and speeds
7. Coolants.

Inherent Machinability of the Alloy: The alloys used in jet engines are generally considered to be in the difficult-to-machine class. This is not strange when you find such elements as cobalt, chromium, molybdenum and titanium as major constituents of the alloys—these same elements make up the high-speed cutting tools. An excellent example of this is the use of Stellite for rotating turbine blades. Such parts are rarely machined to shape but are cast close to finish size and ground.

The decision to make a part



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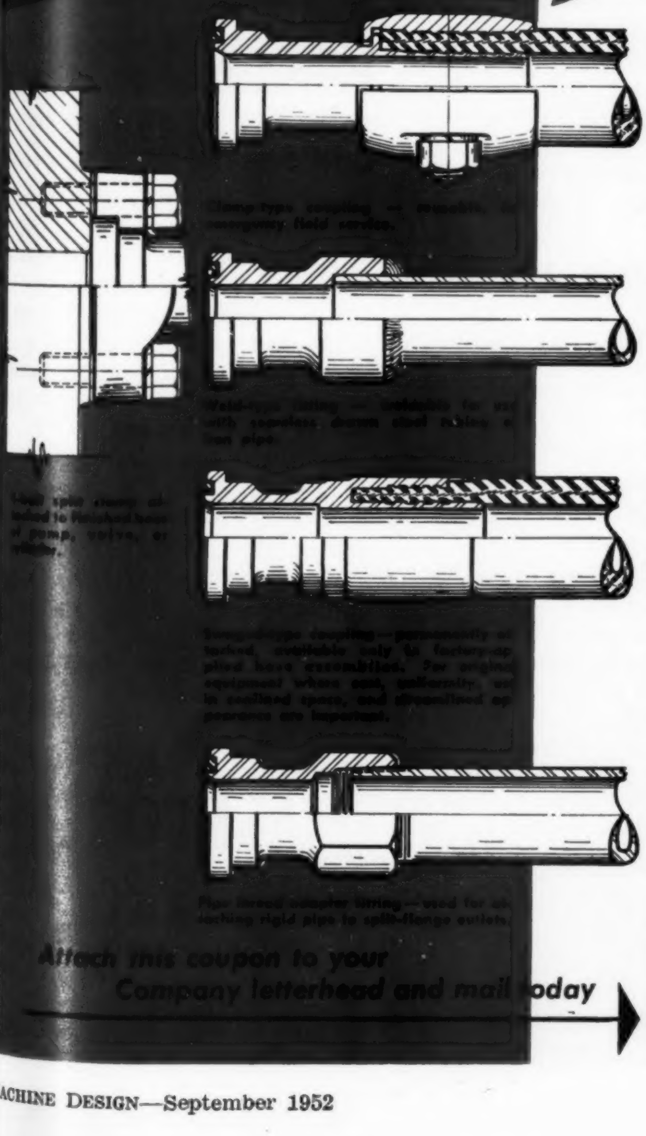

in hydraulic hose assemblies

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LEAKPROOF — the "O" ring, successfully utilized in so many hydraulic applications, provides a perfect seal.

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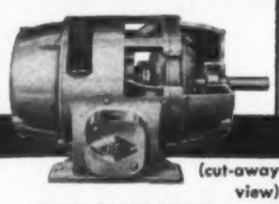

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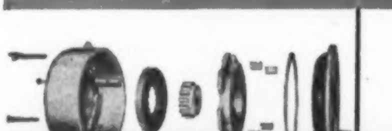

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Design Abstracts

from a specific alloy depends upon meeting the stress requirements, corrosion resistance, and whether the material will be available for production quantities. As the alloy content of the iron base materials goes up, the machinability index goes down. This is readily understandable when you consider that, when the metallurgist adds specific elements to increase hot strength, he also increases the resistance to cutting shear.

Besides this factor of shear strength, other indices are useful in determining the inherent machinability of an alloy. The coefficient of friction is significant as well as being easy to control since changes in coolants, feeds, speeds, tool design affect its magnitude immediately. The plastic properties of the metal have an important effect on the machining constant. Variations in this index are controlled by varying thermal heat treatments. These three factors—shear strength, coefficient of friction and machining constant—plus the hardness, strain hardenability, and the amount of abrasive particles on the metal all affect the inherent machining qualities of the alloy.

Design of The Part Being Fabricated: Basically, the axial-flow gas turbines consist of a series of thin-walled circular elements bolted together and containing the rotating elements. The design trend is to larger diameters and still thinner sections so that increased thrust can be developed for a minimum engine weight.

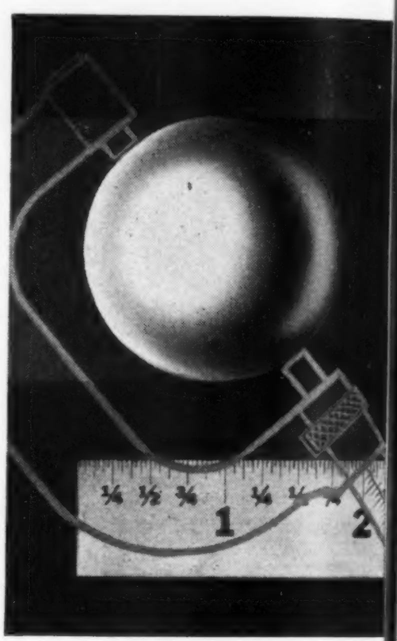
These parts are made from material that is received in the cast or forged condition as sheet metal or bar stock. In the cast condition, the part is cast as close to shape as is practical and then given a solution anneal to establish its optimum machining condition. Centrifugal castings are used to an ever increasing extent.

Compressor disk forgings once purchased as pancakes, now are obtained as contoured forgings. Each of these changes has been made to reduce the amount of machining time on these alloys.

Because the jet engine has to

ONLY A BALL

has { one dimension / one surface



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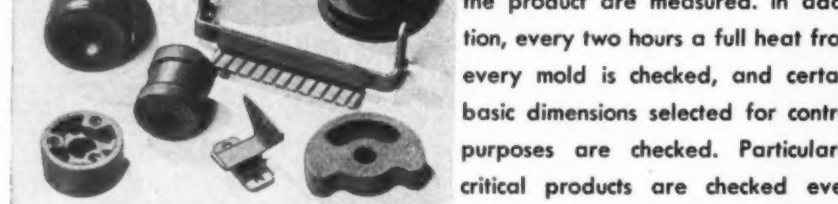


Address all communications to 762 Belleville Ave., New Bedford, Mass.

be in perfect static and dynamic balance, the close tolerances that have to be maintained on all parts pose another problem. A finish-machined compressor disk has a cross-section of less than 0.100-inch in some places. On a disk which is not stress-relieved machining usually causes distortion. English engineers have overcome this by finish-machining both sides of a disk simultaneously.

Design and Type of the Cutting Tool: Use of materials that contain hard carbide particles in a tough matrix, such as the high-temperature alloys, necessitates the use of tools that are abrasion and shock resistant, and have high hot hardness. Carbide tooling is common practice in the jet engine industry today. Standardization of single-point cutting tools has been established along with the most desirable tool design for most of the alloys being used. Because the majority of these alloys exhibit a marked tendency to work-harden, tools must always be rigidly supported and must have keen cutting edges.

Most of the engine lathes used in roughing operations are powered with a 20-hp motor. Roughing out disks on such a lathe taxes the equipment to a maximum. If the operations are performed on vertical turret lathes, which are equipped with 30-hp motors, conditions improve considerably. Heavier cuts can be taken at optimum speeds.

An additional consideration which is of vital importance is the factor of ever increasing diameter of the parts. In the near future a majority of the engine lathes will not be usable for compressor disk work. Lathes with a 60-inch swing will be required. In finish turning, the need for heavy-duty lathes is absent. Lathes with hardened bearings, and special variable-speed motors with shaved and hardened gears must be used. Many manufacturers are now making T-bed lathes to fill this need.

Accessory Tooling: Optimum machining characteristics of these alloys are limited to a fairly nar-

row surface-speed range. This problem becomes critical when one considers that in the turning of a disk with a diameter of 30 inches the surface speed can vary considerably. Today, most machine tools do not have enough versatility in the low-speed range of 15 to 50 rpm that is required to maintain a uniform surface speed across the surface of a disk.

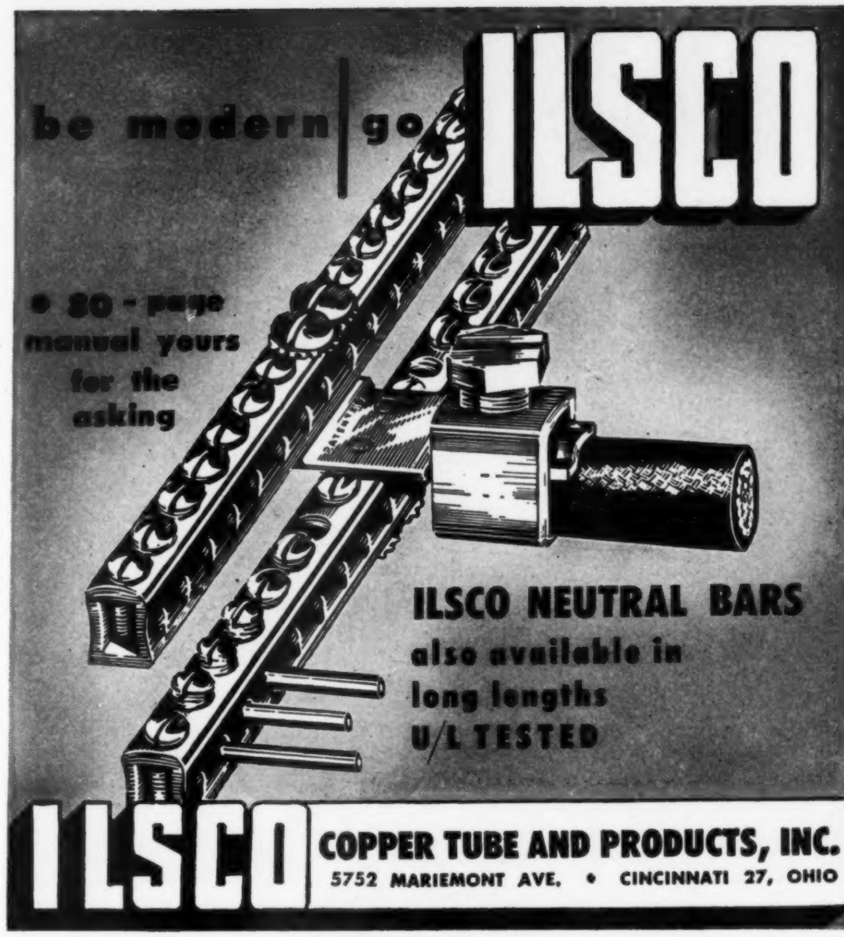
Contour machining of disks is difficult when done by hand feeding. It need not be so if there is incorporated a means for having the operation controlled from a master tracing. Many automatic feeding heads are available today such as cams, templates, magnetic wire, punched tape, and others.

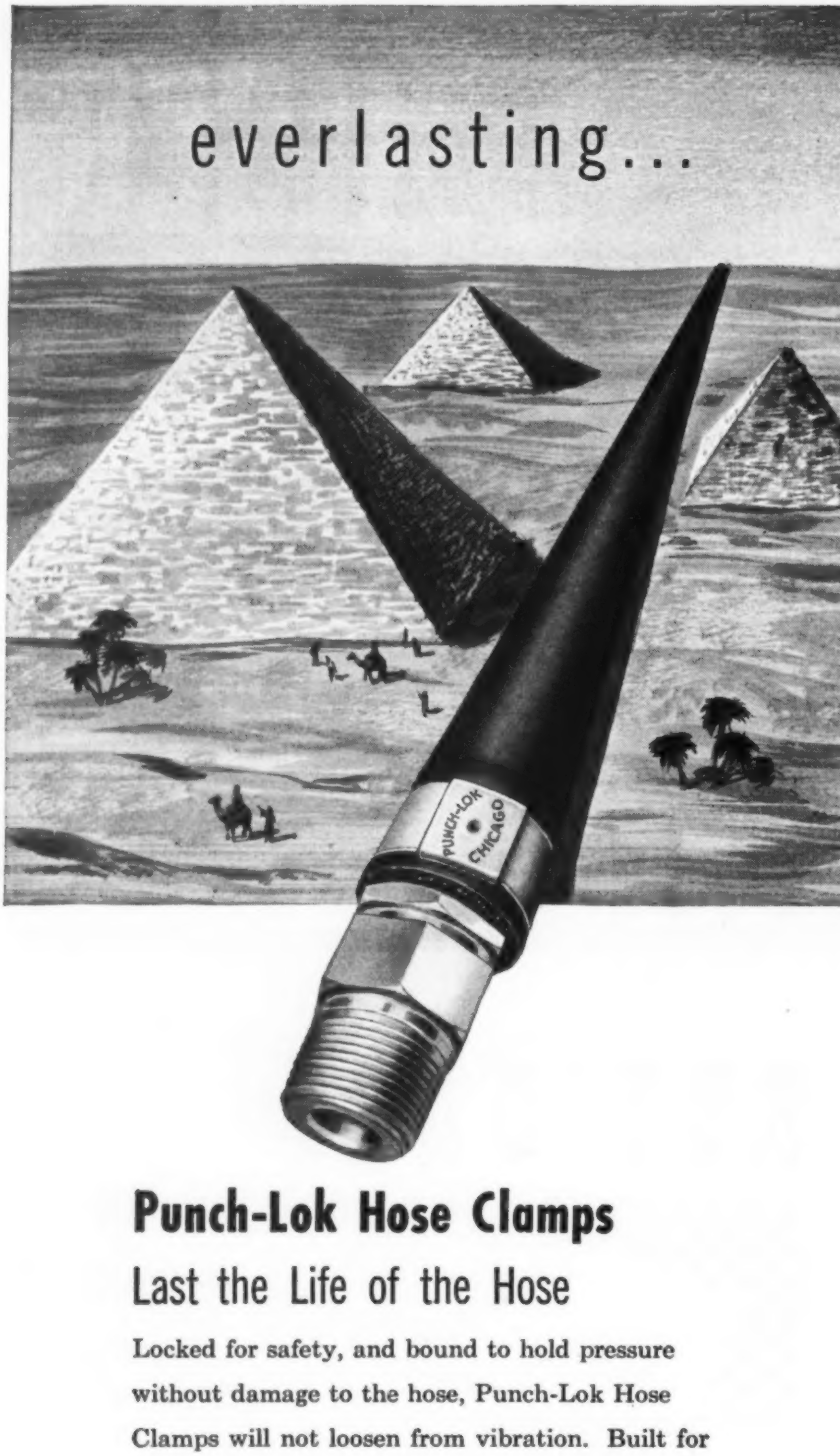
Now that machines are more and more automatic, there is a new problem to consider which is overlooked too frequently—how to dispose of the chips automatically. These automatic machines lose much of their value when the chips are allowed to accumulate. Also, faster and more rigid methods of clamping are needed to accompany the trend of automation in tooling. It is not unusual to see a fully automatic tool with hand-clamping devices.

Feeds and Speeds: Of particular significance is the steep climb in volume of metal removed at the lower range of speeds. Also volume factor increases rapidly with increasing feed and depth of cut. Advantage cannot be taken of this unless the machine tool builder constructs a more rigid machine with higher horsepower motors.

Surface finish is dependent upon feed and speed as in all finishing operations. It is accentuated in the high-temperature alloys due to their work hardening characteristics. If these parts are finish-machined in the hardened condition, this factor diminishes in importance.

Coolants: It is axiomatic that if the action of the coolant is to be of value it has to be available at the cutting edge at the instant of cutting. This type of thinking has led to the application of carbon





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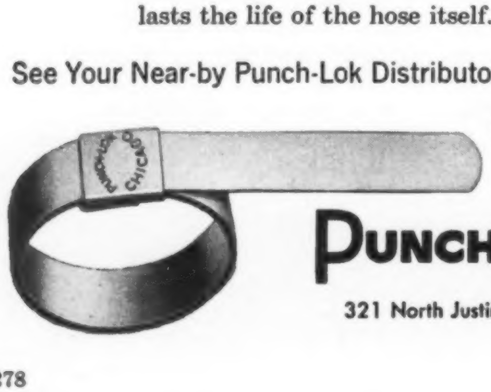
"The Sign of a Good Hose Clamp"



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dioxide and Gulf Hi-Jet process.

Carbon dioxide is only a coolant whereas in the latter process it is possible to have a chemical reaction at the tool-tip work-piece interface to form a soft ionic chloride crystal on the tool to act as a lubricant. That this happens has been proved by the use of carbon tetrachloride as a coolant. It has no lubricity, but it does furnish chloride ions to the tool tip.

By the intelligent use of coolants, a machining job can be aided. However, too often the coolant is cooling the work of the tool but not the cutting zone and, therefore, no value is received.

From a paper entitled, "The Machining of High Temperature Alloys," presented at the 16th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corp., in Pittsburgh, Pa., April 1952.

University Research Potential

INDUSTRIES based on machines and the metals they are made from can still look to American colleges and universities for research talent to help keep them abreast of the times. Today's shortages of technical manpower emphasizes the value of these resources.

A recent survey shows very substantial untapped potential for research in mechanical engineering at most schools, and some reserves are still available in metallurgy. Only one-third of the mechanical engineers on college and university faculties now have research underway. At least 950 remain ready and qualified to undertake studies. There is far less room for expansion in metallurgy, where more than 75 per cent of qualified faculty already have projects underway. Yet about 100 metallurgists are still without research assignments.

In these cases, of course, research must be a part-time activity. But most faculty members—especially with today's decreased engineering enrollments—can plan re-

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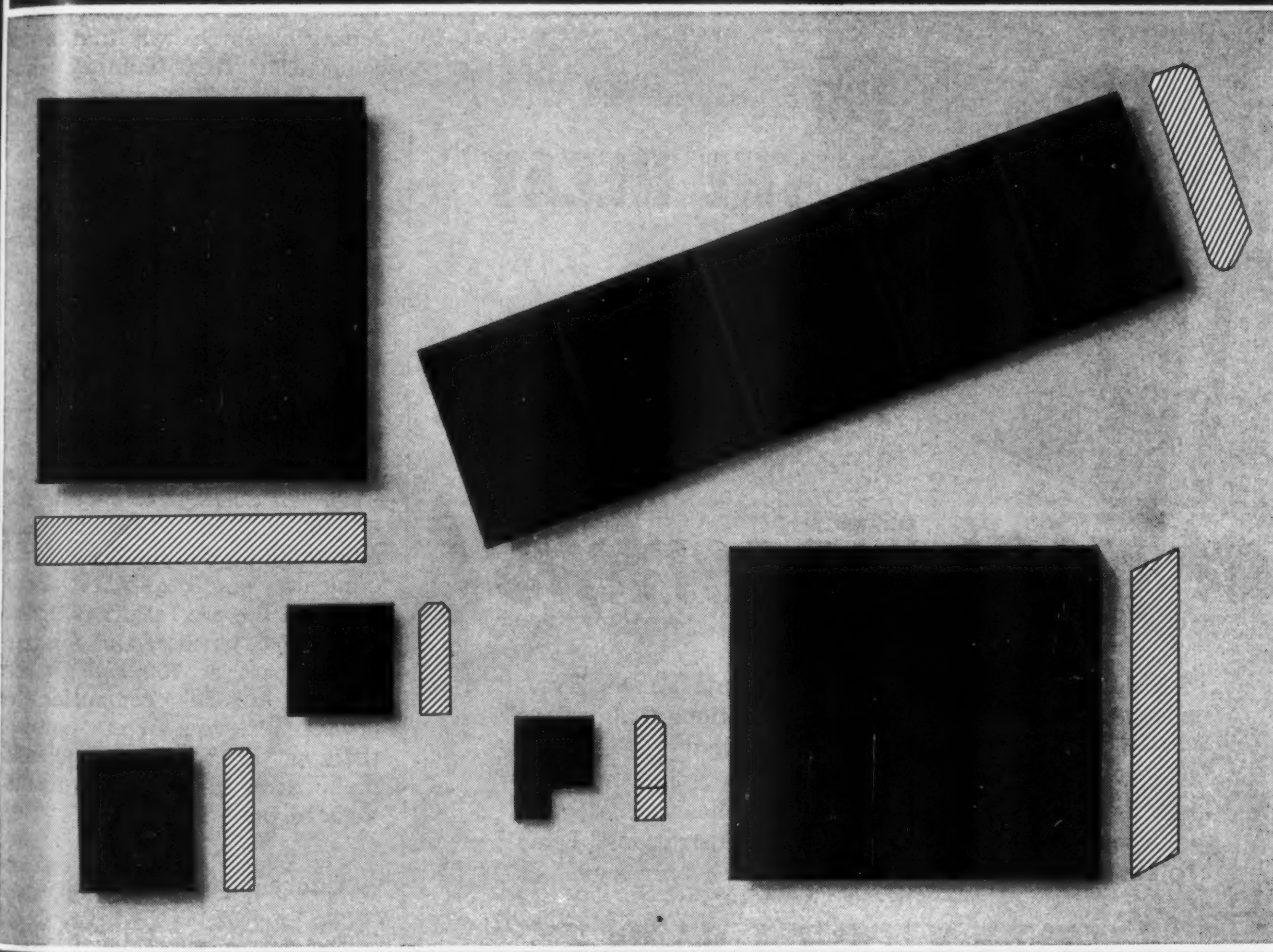

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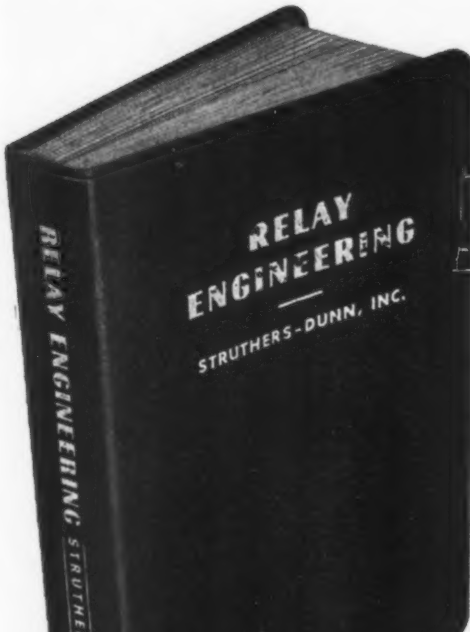

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search projects amounting to one-quarter or one-third time. Graduate students and junior instructors are available to complement and add to this research potential.

In the case of metallurgy, industries seeking college and university research will find severe competition from military agencies; already 70 per cent of the schools' research time in this field is devoted to such studies. Only 47.5 per cent of college and university mechanical engineering research is under military sponsorship.

This picture of engineering research in educational institutions comes from a national inventory of college and university research resources completed this summer by the Engineering College Research Council, a unit of the American Society for Engineering Education. Over 24,000 faculty members—and an equal number of graduate students—were inventoried in the project. They include all those in physical and engineering sciences at 750 colleges and universities. The committee believes its figures cover "substantially all" of the national potential for research in educational institutions in these fields.

Concentration in Sciences

The survey showed a considerable concentration of college and university research in all physical and engineering sciences. In general, large schools spend much more of their total effort on research than smaller ones. Defense research especially shows this type of concentration. Schools with extensive nondefense research tend to be those given largest additional opportunities through defense agencies' contracts. Only 15 institutions account for one-half the nation's total faculty time spent on defense research. At these schools, defense studies alone take one-third of the total effort in the engineering and physical sciences.

No such extreme concentration appears in mechanical engineering. Almost without exception schools reporting qualified faculty say

that many of these teachers now have no research in progress. In the eight schools reporting the largest mechanical engineering research totals, for example, 87 faculty members have no projects underway.

Mechanical engineering defense responsibilities are not so widely shared. Five schools have 48.5 per cent of all defense research in mechanical engineering in American colleges and universities. This "big five" group reports only 10 per cent of all the nation's qualified faculty and its members do 25 per cent of all mechanical engineering research. Even in this group 48 teachers who are qualified to do research have no projects underway.

Metallurgy Potential

Four schools—out of a total of 113 reporting qualified faculty members—are today responsible for 41 per cent of the college and university defense research in metallurgy. These four have only 22 per cent of the qualified faculty reported by all educational institutions, and 90 per cent of the research in their laboratories is for defense, compared to the national average of 70 per cent.

In this "big four", defense reseach represents one-half of the total college effort in metallurgy. Nondefense research for industry is virtually nonexistent.

Much the same situation applies in other schools; in all institutions with any defense research assignments in metallurgy essentially all research capacity is already at the service of federal research. Defense research accounts for nearly 95 per cent of the total faculty research time at these institutions, and 90 per cent of the faculty members considered qualified for research have projects underway.

In all, there are 109 metallurgical engineering teachers ready for research who have no projects now active. With few exceptions, these teachers are at 82 schools holding no defense contracts. If these "unemployed" faculty members add one-third time research work to their teaching duties, college and

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The accompanying illustrations show a few of the successful applications of this SKF principle —on roll neck bearings in steel mills, printing cylinder and paper mill roll bearings, on SKF "OK" Shaft Couplings, main and crank pin bearings in air compressors. The principle is also well suited to other equipment such as crushers, construction machinery, etc.

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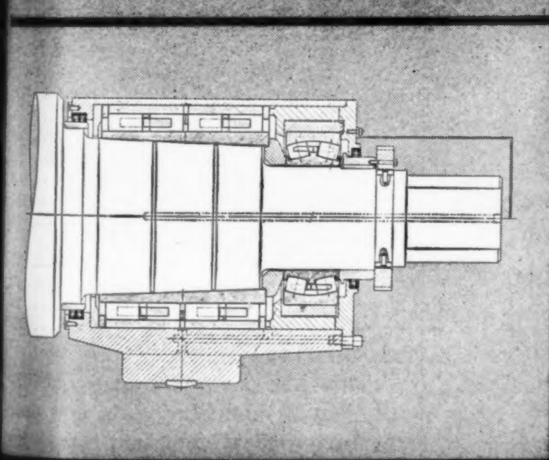
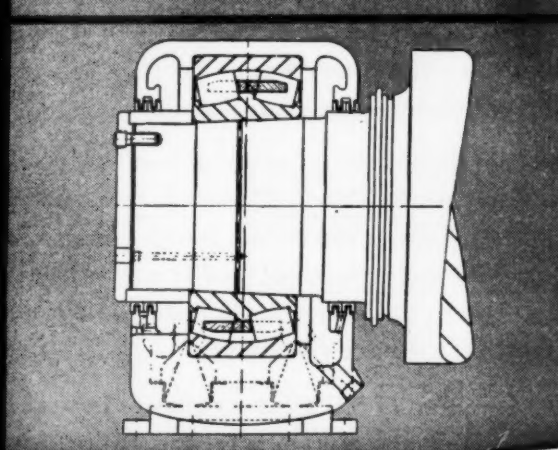
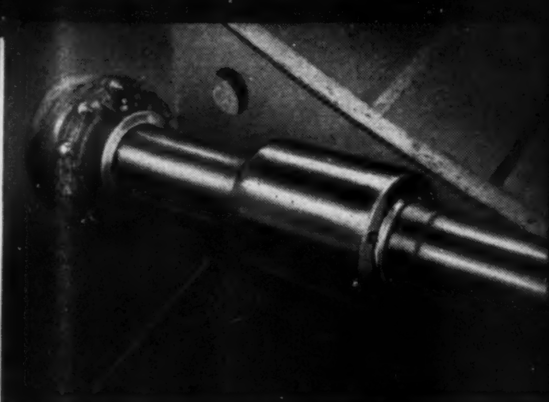


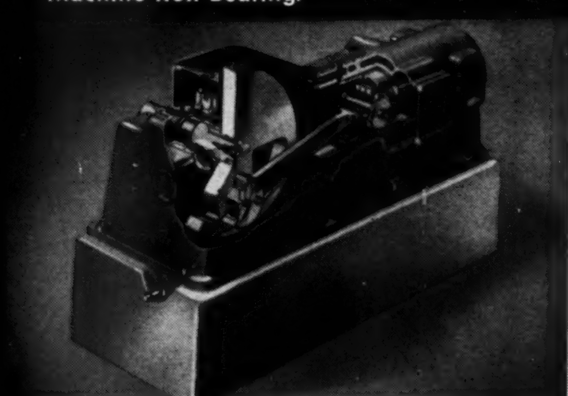
Typical Application Of SKF Hydraulic Mounting For Roll Neck Bearing.



Typical Application Of SKF Hydraulic Mounting For Printing Cylinder And Paper Machine Roll Bearing.

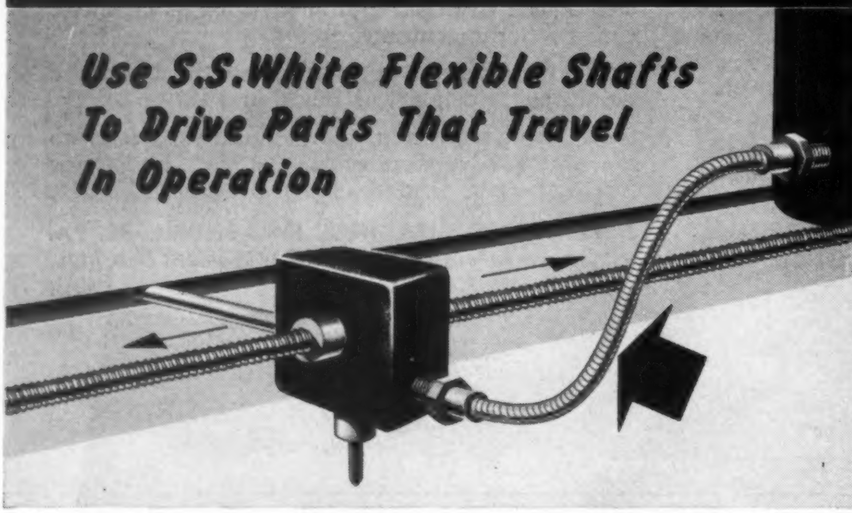


"OK" Coupling On 7⅜" Marine Shaft, Depends On Pressure Only To Transmit Torque. Separable By SKF Hydraulic System.



SKF Roller Main And Crank Pin Bearings With Hydraulic Mounting Feature On A Pneumatic Compressor.

THERE'S AN IDEA HERE FOR SOME DESIGN ENGINEER



The hypothetical application above demonstrates one of the important advantages of an S.S.White flexible shaft — its ability to provide rotary power between any two points regardless of their relative positions.

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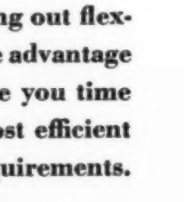

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university metallurgy research can go up by 20 per cent.

Many fields of specialization are included in the interests of these college and university faculty members. The number of schools reporting one or more teachers interested and qualified in the different areas of mechanical engineering and metallurgy research are shown in the following list.

Mechanical Engineering
- Automotive engineering 75
- Gyroscopes and gyroscopic instruments.. 24
- Heating, ventilating and air conditioning 134
- Industrial furnaces 22
- Internal combustion engines 132
- Jet and gas turbine engines 61
- Lubrication and friction 62
- Machinery and machine design 120
- Machine tool engineering 63
- Mechanical control systems 37
- Mechanical properties of materials 75
- Power and steam generation and use ... 97
- Refrigeration 93
- Stress analysis and photoelasticity 84
- Textile machinery 9
- Thermodynamics, heat and heat transfer 128
- Tropical and low-temperature testing.. 23

Metallurgical Engineering
- Corrosion and erosion 52
- High temperature materials 36
- Metallurgical analysis 45
- Physical metallurgy:
  - Fabrication and finishing 38
  - Ferrous alloys 75
  - Foundry 56
  - Light metals and alloys 64
  - Metallography 96
  - Nonferrous alloys 62
  - Powder metallurgy 39
  - Theory of metals 61
  - Welding 54
- Process metallurgy:
  - Electro metallurgy 33
  - Ferrous processes 33
  - Hydrometallurgy 24
  - Nonferrous chemical metallurgy 23
  - Nonferrous pyrometallurgy 12

This list obviously does not imply equal competence on the part of each educational institution indicated; potential contractors and sponsors must still select with care institutions to receive contracts for specific projects. But it does show that broad resources are available.

Many research projects in these fields require specialized equipment not available at all schools. In general, however, the Engineering College Research Council committee regarded qualified personnel as the principal bottleneck in the current necessary expansion of research; if competent manpower is available, necessary equipment can probably be supplied to the potential research workers.

Nevertheless, the committee attempted an incomplete inventory of items of specialized equipment

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United States Rubber Company engineers developed this homogeneous pad to meet every exacting specification of the aircraft manufacturer. It makes possible better formed parts—by providing pressure throughout so that every part of metal is subject to proper forming pressure. The laminated pads originally used did not last long, due to ply-separation, and failed to provide uniform pressure.

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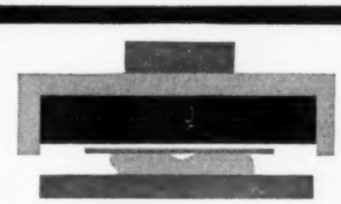
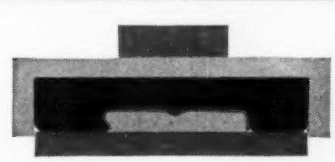
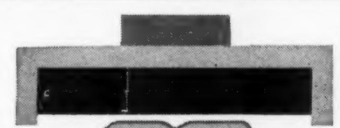


Sheet metal blank is placed on the die before pad of resilient material presses down on it.



Rubber pad becomes completely entrapped and flows under pressure into the open spaces, thus completing the forming.



Press cycle is completed by raising pad which regains original shape. Part stays formed to die.

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found only uncommonly at educational institutions. Thus, some items such as cryostats, furnaces, spectrographs, and testing machines were listed by schools and colleges where available—in the belief that these equipment items might be an important factor in the location of specific research. No statistical summaries of equipment inventoried have been undertaken, but details may be obtained from the full report of the project.

Decentralization Needed

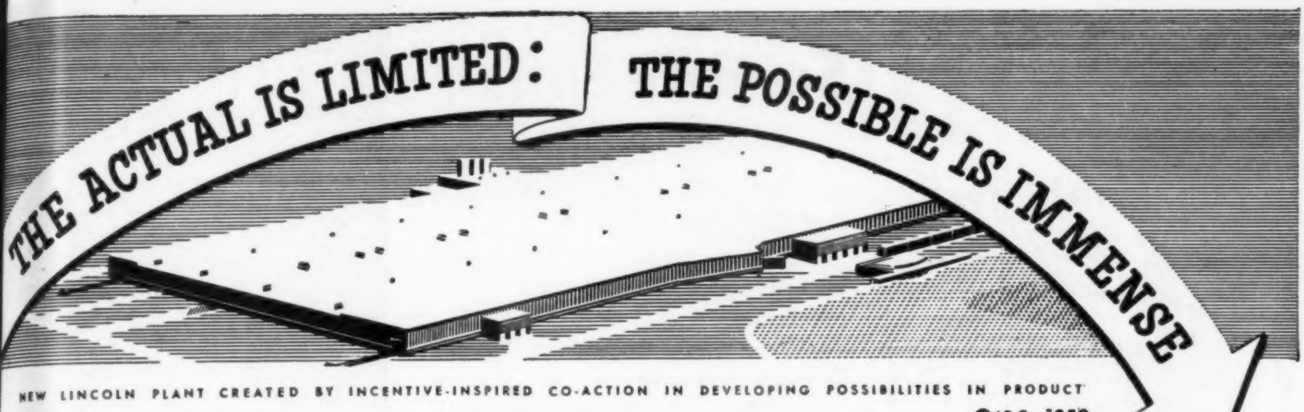
Decentralization is obviously the key to any expansion of the universities' contribution to metallurgy research. To a lesser degree the same is true of mechanical engineering, for it is in the national interest to extend the benefits of research to as many institutions as possible. Military agencies, particularly, can help by broadening their operations into a larger number of schools.

No selfish motives prompt the colleges to make this suggestion. All agree that any research expansion must be limited by the demands of teaching—to which all schools must give first attention and priority. Research can easily become the tail that wags the dog, robbing students of adequate instruction and faculty of necessary freedom.

But within these sensible limits, fundamental research projects can be effectively integrated with the educational program and can make important contributions to it. Such projects help schools give wider opportunities and better salaries to competent faculty. Students benefit by acquaintance with real industrial problems and research methods.

In both ways, increased research undertakings will result in better qualified graduates for industry. Many sponsors consider this an important factor in university projects—second only to development of needed technical information.

From a report of the same title by the Engineering College Research Council of the ASEE; summarized by John Mattill, Secretary of the Council.



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The Porter Cable Machine Co., Syracuse, New York

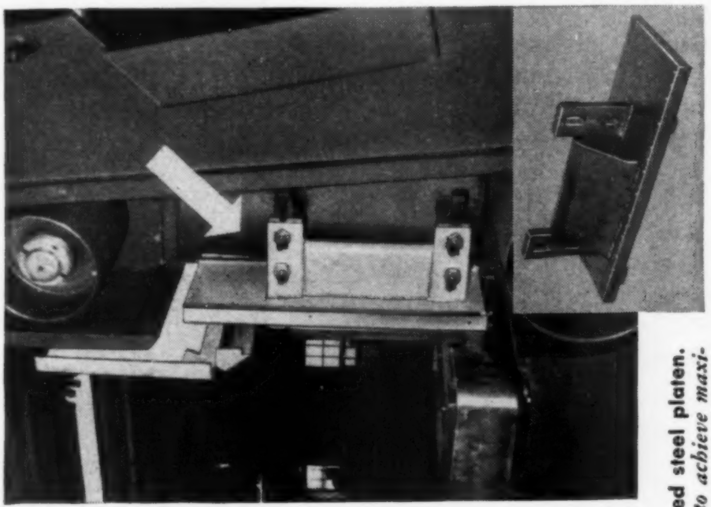

Fig. 3—Detail of Column *on Porter Cable BG-8 Grinder. Shows assembly of belt platen support governing the ultimate accuracy and efficiency of the machine.*

Inset: Rear view of welded steel platen. *Shows efficient use of steel to achieve maximum strength and rigidity per pound of metal.*

By changing over the design of our belt platen support to welded steel construction, we have cut deflection over 90%. The former cast construction, (Fig. 1) would deflect from .017" to .020" under 400 pound table pressure. The present welded steel design deflects only .0015" to .002" ... 10% of its original value.

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Fig. 1—Former Design—*Belt platen support for grinder was originally a casting. Required machining operations to finish the front face and the mounting arms.*

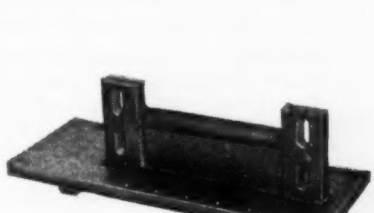

Fig. 2—Present Design in Welded Steel—*Is simpler to fabricate than the original construction. Components are pre-machined prior to welded assembly to simplify manufacture.*

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Surface Finish

(Continued from Page 290)

jects of particular interest in the field of surface finish.

ACKNOWLEDGEMENTS: The writer wishes to express particular appreciation to the Engineering Index Inc., The H. H. Wilson Co. and the American Society for Metals for permission to use abstracts from their publications. The assistance of these organizations was of inestimable value in the preparation of this review. These three sources are identified in the abstracts as follows:

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Industrial Arts Index of The H. H. Wilson Co.... IAI
American Society for Metals .... ASM

Permission of the Department of Defense to publish this paper is acknowledged.

1951

1-51. "Visual and Optical Evaluation of Metal Surfaces"—Helmut Thielsch; *Metal Finishing*, v. 49, May 1951, pp. 54-61. Various methods of evaluating surfaces of metal are reviewed. Optical methods include: sight, projection, optical comparator, rigid replicas, lightfield illumination optical sectioning, cross sectioning, taper sectioning, binocular microscope, stereomicroscopy, dark field illumination, pliable replicas, interferometry. Photomicrographs, tracer recordings, photographs, tabulations presented. Chart compares various methods.

2-51. "Surface Finish Standards"—T. E. Cassey and J. W. Sawyer; MACHINE DESIGN, v. 23, May 1951, pp. 137-140. Uniform practice of specifying surface roughness, waviness and lay, as adapted by the U. S. Department of Defense.

3-51. "Contour Mapping of Optical Surfaces with Light Waves"—*Product Engineering*, v. 22, n. 7, July 1951, p. 155. Method of contour mapping of precise optical surfaces developed by the National Bureau of Standards.

4-51. "Engineering for Producibility" — Roger W. Bolz, MACHINE DESIGN, v. 23, n. 8, August 1951, pp. 150-152. Includes chart showing basic machining processes, their overall and normal commercial range of surface roughness, and their accompanying range of practical dimensional tolerances. Other charts show overall and average range of natural surface roughness characteristic with the non-machining processes, and characteristic maximum surface roughness for common machine parts.

5-51. "An Instrument for Automatically Recording Waviness of Surfaces"—C. W. Medhurst; *Journal of Scientific Instruments*, v. 28, n. 7, July 1951, pp. 211-214. Instrument automatically records on graph paper the waviness of surfaces. Considered suitable for production work.

6-51. "Fretting Corrosion"—*The Allen Engineering Review*, n. 27, July 1951, pp. 2-4. Definition, indicated by reddish brown deposit resembling mill scale. Surfaces with high degree of finish are more affected than rough ones. Bibliography.

7-51. "Surface Finish Photometer"—*Journal of Scientific Instruments*, v. 28, n. 9, September 1951, pp. 289-290. This instrument, manufactured by Hilger and Watts Ltd., Lon-

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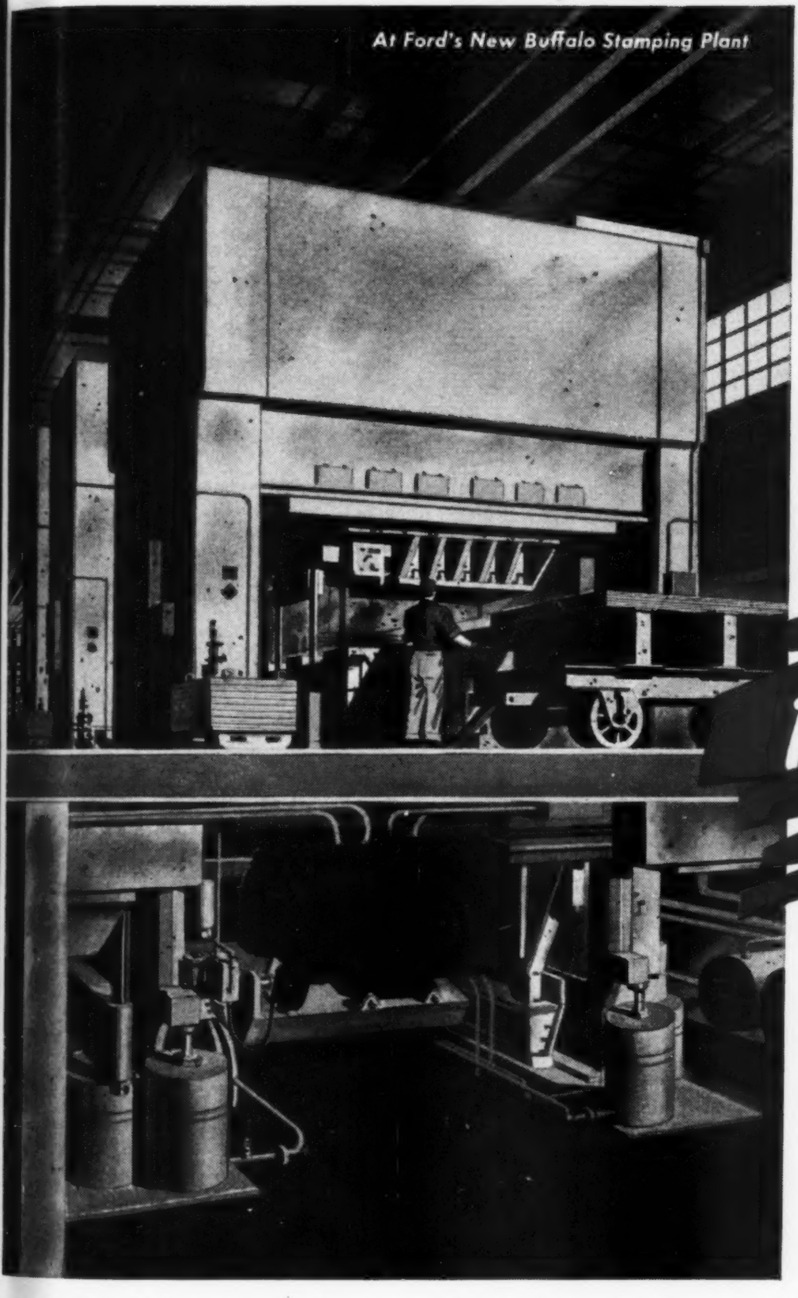

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don, measures photoelectrically the light diffusely reflected from a surface under test. Test specimen may be compared with standard surfaces. A measurement of degree of polish or "matness" of any surface is feasible. Objects, approximately flat, may be checked if ½-inch diameter or larger.

8-51. "A Simple Instrument for Evaluating Polished Buffed Surfaces"—G. E. Gardam; *Metal Finishing*, v. 49, April 1951, pp. 61-63. Qualitative measurement of polished or buffed surfaces with a simple instrument.

9-51. "Assessing Surface Texture"—*Engineering*, v. 171, April 6, 1951, p. 409. Discussion of *British Standard* 1134-1950, "The Assessment of Surface Texture."

1950

1-50. "Evaluating Casting Finishes"—H. H. Fairfield and J. MacConachie; *American Foundryman*, v. 17, n. 2, February 1950, pp. 47-48. Importance of finish stressed; graph of 25 profile measurements of cast surface made with needle-tipped dial indicator, presented with tables showing how to calculate probable maximum depth of valleys and average height of hill for aluminum, brass, iron and steel; degree of smoothness depends upon metal type. (EI)

2-50. "The Assessment of Surface Texture Centre Line—Average Height Method"—*British Standard* 1134-1950, British Standards Institution, London. Standard provides: (1) a defined basis for a simple numerical assessment of texture or roughness of a surface under conditions which ensure consistency between different instruments; (2) series of recommendations which help prevent conflicting practices in use of terms and symbols. Contents include definitions, terms, measuring instruments, standard sampling length and wave length cut-offs, British standard index numbers, standard grades of surface texture, surface texture symbols, remarks on surface profiles, determination of C. L. A. index numbers, notes on direction of measurement, notes on instrumentation, analysis of surface texture, choice of sampling lengths and alternative assessments of surface texture.

3-50. "Permanent Gloss Standards"—*Illuminating Engineering*, v. 45, n. 2, February 1950, p. 101. Data on Bureau of Standards plaques covering entire gloss range of nonmetallic commercial materials; standards may be used to calibrate any 60 degrees specular glossmeter from matte to high gloss; set consists of two white Vitrolite plaques having nominal gloss values 1 and 90, and eight intermediate glazed ceramic plaques. From *U. S. Bureau of Standards Technical News Bulletin*, October 1949. (EI)

4-50. "New Yardstick Accurately Gages Surface Finish"—*Modern Industry*, v. 19, January 1950, pp. 99-100. (IAI)

5-50. "An Electro-Deposited Surface Roughness Standard"—P. M. Aitchison; *Australian Journal of Applied Science*, v. 1, March 1950, pp. 71-74. Standard consists of a lapped steel block on which are deposited thin strips of specified width, spacing and height. This provides a known surface for use in calibration of stylus type surface finish measuring instruments. (ASM)

6-50. "On Determination of Roughness of Metallic Surfaces"—C. Wagner; *Electrochemical Society Journal*, v. 97, n. 3, March, 1950, pp. 71-74. Experiments described show applicability of ballistic galvanometer to determine polarization capacities of electrodes. Measurements made in connection with development of electrolytic integrimeter, described by T. M. Moore (See *Engineering Index*, 1946, p. 988, under "Rocket Propulsion.") It can be shown that ultimate accuracy of integrimeter is determined by magnitude of polarization capacity of silver electrode used therein. Bibliography. (EI)

7-50. "Photography of Surface"—*Engineering Inspection*, v. 14, n. 1, Spring 1950, pp. 39-41. Use of photography in connection with surface measurement, particularly in testing and recording of superfinished surfaces; photography as related to nature of blemishes to which such surfaces are subject; application of photography to measurement of crystal faces of diamond and other gems, or in checking grinding of razor blades. (EI)

8-50. "Contour and Profile Investigation,

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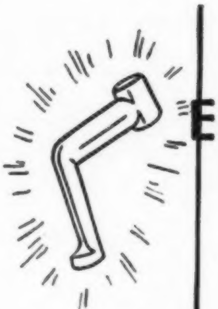

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Surface Finish

Part 1"—*Aircraft Production,* v. 12, May 1950, pp. 161-166. Inspection of gas turbine components by a British firm. Includes recording of profiles on smoked glass. (ASM)

9-50. "Surface Roughness and Contact Angle"—J. J. Bikerman; *Journal of Physical and Colloid Chemistry,* v. 54, n. 5, May 1950, pp. 653-658. Contact angles and wetting as related to roughness; studies in which contact angles were measured using solid surfaces, profiles of which were determined with tracer instrument. System investigated comprised drops of distilled water in air on 18-8 stainless steel plate of different finishes; chemical composition of all plates stated to be identical. (EI)

10-50. "Measurement of Surface Smoothness"—Henry L. Kellner; *37th Annual Proceedings Technical Sessions,* American Electroplaters' Society, 1950, pp. 105-124. Instruments, methods and test data presented. Microscopic methods, microinterferometer, Brush Surface Analyzer, Profilometer, acoustical methods, replica technique, electron microscope and reflectance methods are presented. Data on tests with various instruments are given.

11-50. "A Simple Instrument for Measuring 'Surface Truth' of Metal Surfaces and the Amount of Polishing Required"—G. E. Gardam, *Journal of the Electrodepositors' Technical Society,* v. 26, 1950. Qualitative measurements can be made by visual examinations of surfaces with the instrument described.

12-50. "Contour and Profile Investigation: Part 2—Work Holding Devices, Comparator Equipment and Special Purpose Optical Apparatus for Dual Projection: Part 3—Epidiascope-type Filing Projector; Checking Fir Tree Roots"—*Aircraft Production,* v. 12, June 1950, pp. 192-197; July 1950, pp. 232-234. Techniques and equipment developed at D. Napier and Son Ltd. for inspection of gas turbine blades and similar work. (ASM)

13-50. "Measurement of Sixty-Degree Specular Gloss"— H. K. Hammond III and I. Nimeroff, *National Bureau of Standards Journal of Research,* v. 44, n. 6, June 1950 (RP2105), pp. 585-598. See also *ASTM Bulletin,* n. 169, October 1950, pp. 54-56. In order to determine uncertainties involved in calibration of gloss standards, rate of change of gloss reading with change of aperature was investigated throughout gloss scale. (EI)

14-50. "Watch Your Surface Finish, Part 1"—*Steel,* v. 126, June 19, 1950, pp. 88-90, 115-116. General discussion of terminology, costs, etc. Surface finishing measuring instruments. (ASM)

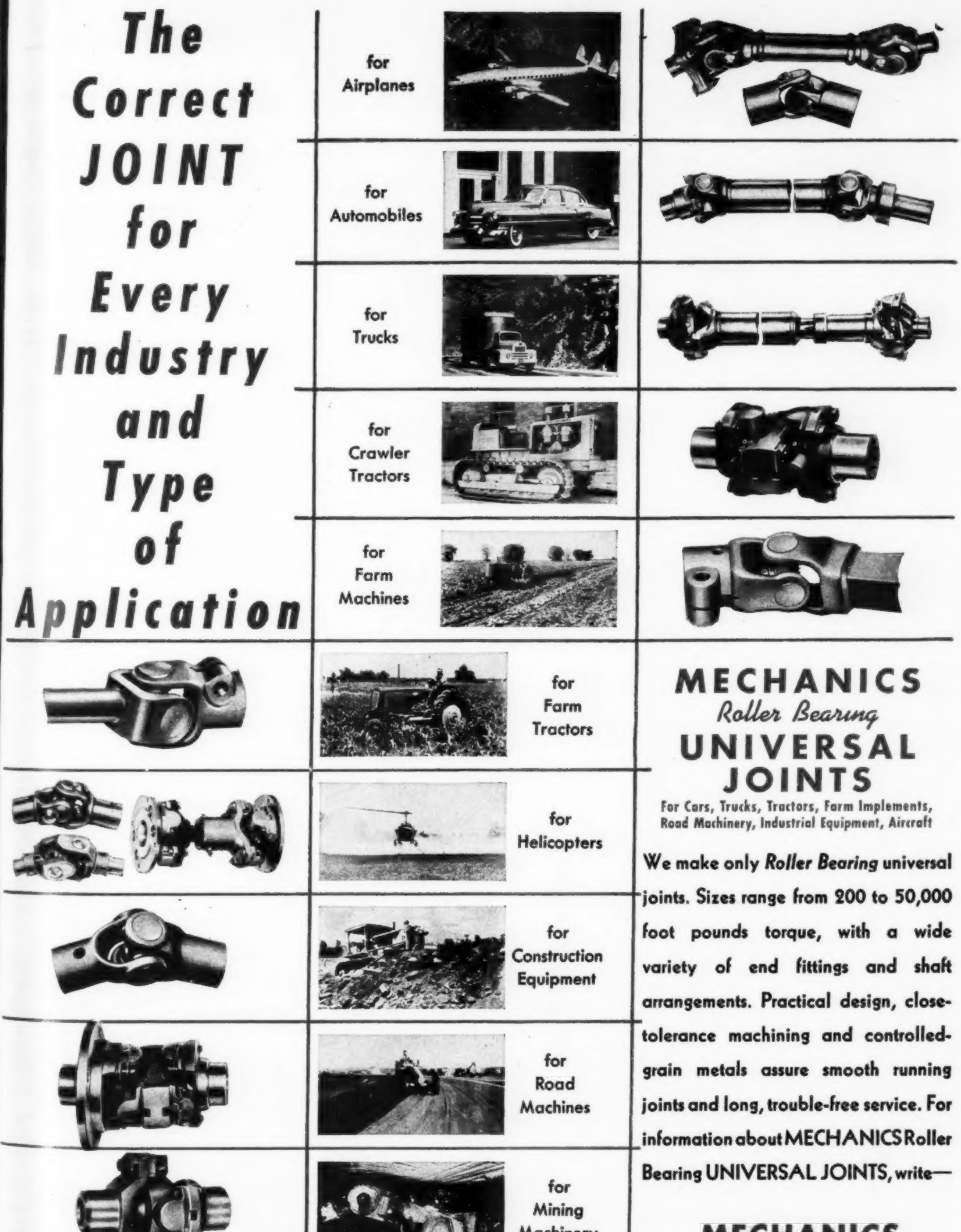
15-50. "Measurement of Surface Roughness, Part 1"—E. Green; *Finish,* v. 7, June 1950, pp. 27-30. Instruments and methods used for comparing, measuring, and delineating surface profiles of metallic materials. (ASM)

16-50. "Surface Finish Control"—C. R. Lewis; *Product Engineering,* v. 21, August 1950, pp. 91-95. Problem of finish specification, new SAE standards and various effects below surfaces of metals caused by different finishing operations are discussed. Curves show test data. SAE standard; effect of finish on metal; depth of cold working; X-ray inspection; electron diffraction; stainless steel 18-8; performance of machined parts; friction coefficient; run-in of bearings; bearing lubrication; fatigue endurance; National Bureau of Standards; wear rate; protective coating.

17-50. "Surface Finish Definitions and Standards"—*Product Engineering,* v. 21, August 1950, pp. 163, 165, 167. Based on surface finish section of the new *SAE Automotive Drafting Standards.* Definition profile waviness, microinch, lay, flows, surface finish symbol. Waviness standards adopted by SAE. (ASM)

18-50. "Recording Surface Finish and Wear of Gear Teeth"—J. W. Sawyer and J. G. McCubbin, *Machinery,* v. 56, n. 12, August 1950, pp. 135-142. Comparison of various methods employed for studying roughness and progressive wear of gear teeth is presented; inspecting finish by comparison with standards; pliable film method of producing record of surface of gear teeth; rigid casting methods of producing replicas of gear teeth. (EI)

19-50. "Methods of Measurement and Definition of Surfaces"—H. Becker; *Microtechnic* (English Edition), v. 4, July-August 1950 (translated from the German). Various optical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instruments. Schematic diagrams show principles of action. (ASM)

20-50. "Effect of Micro-Roughness on the performance of Parallel Thrust Bearings"—M. E. Salamail; *Proceedings of the Institution of Mechanical Engineers* 163 (W. E. P. No. 59), pp. 149-158; discussion, pp. 158-161; 1950 (IAI)

21-50. "Designation of Metallic Surfaces, Part 1"—Helmet Thielsch and George Stroman; *Metal Finishing*, v. 48, n. 9, September 1950, pp. 66-70. Fundamentals of surface qualities, terms, methods, instruments and standards are discussed. Bibliography.

22-50. "Surface Testing and Its Standardization"—H. Becker, *Metall*, v. 4, September 1950, pp. 359-365. (In German). The "feeler" method of determining and recording surface roughness. German and foreign instruments and problems of standardizing surface conditions. (ASM)

23-50. "Surface Finish and the Designer"—Roy P. Trowbridge; *Product Engineering*, v. 21, September 1950, pp. 122-127. New approach to measurement, specification and application of surface finish control of metallic parts. Instruments, standards for various production methods, and physical properties relating to condition of metallic surface are compared and evaluated. Instruments include brush analyzer, profilometer, proficorders, interferometer (Bausch and Lomb), dark and light field microscopy, Sheffield gage, and comparascope. Taper sectioning. Geometric specimen, electroplated specimen, replicas. Methods include turning, grinding, honing, superfinishing, forging, and casting.

24-50. "Multiple-Beam Interferometry"—S. Tolansky; *Endeavour*, v. 9, October 1950, pp. 196-202. Technique and typical results. (ASM)

25-50. "Instrument Compares Surface Finishes"—*Product Engineering*, v. 21, December 1950, p. 204. Pneumatic type instrument permits comparison of surfaces with known standards. Surface 0.125-inch diameter can be checked. Instrument manufactured by Sheffield Gage Co.

1949

1-49. "Practical Application of Surface Finish"—George Schlesinger; *American Machinist*, v. 93, January 13, 1949, pp. 101-110. Results of shop experience with tracer type or stylus instruments from 1939 to 1948. Tests were made to determine surface quality as the criterion for tool sharpness in diamond turning, precision boring, grinding, honing, lapping, and gear cutting. Examples of analyses of gear-tooth profiles produced by available processes, finishing of pistons and liners for air compressors, diamond boring a bushing and turning railway wheels. (ASM)

2-49. "Preparation and Application of Reproducible Gloss Standards"—D. Smith and M. M. Mahoney. *Journal of the Optical Society of America*, v. 39, n. 1, January 1949, pp. 86-90. Determination of factors involved in visual evaluation of gloss; polystyrene replica technique used to prepare extremely thin films of identical surface structure; transfer of these films to any desirable surface; reproducibility in surface structure and spatial reflectance characteristics of replicas made from gloss standards. (EI)

3-49. "Interferometric Study of Metal Surfaces"—S. Tolansky; *Metal Treatment and Drop Forging*, v. 16, n. 60, Winter 1949-50, pp. 195-203. Principles and techniques of interferometry develops in author's laboratories; how interferometry may be applied to study of metal surfaces.

4-49. "Applications of the Plastic Replica Process to Surface Finish Measurement"—C. Timms and C. A. Scoles; *Plastics* (London), v. 13, January 1949, pp. 24-28, 44. Use of plastic impressions for measuring the degree of surface finish of large engineering components which are not readily accessible to the exploring probes of standard designs of surface-finish recording instruments. The process consists of taking a plastic replica, the impression thus obtained being measured directly by means of a stylus recording instrument. Typical recorder charts. (ASM)

5-49. "Surface Reflectometer for Evaluating Polished Surfaces"—E. A. Ollard; *Journal of the Electrodepositors' Technical Society*, v. 24, 1948, pp. 1-8. (Reprint.) Instrument for

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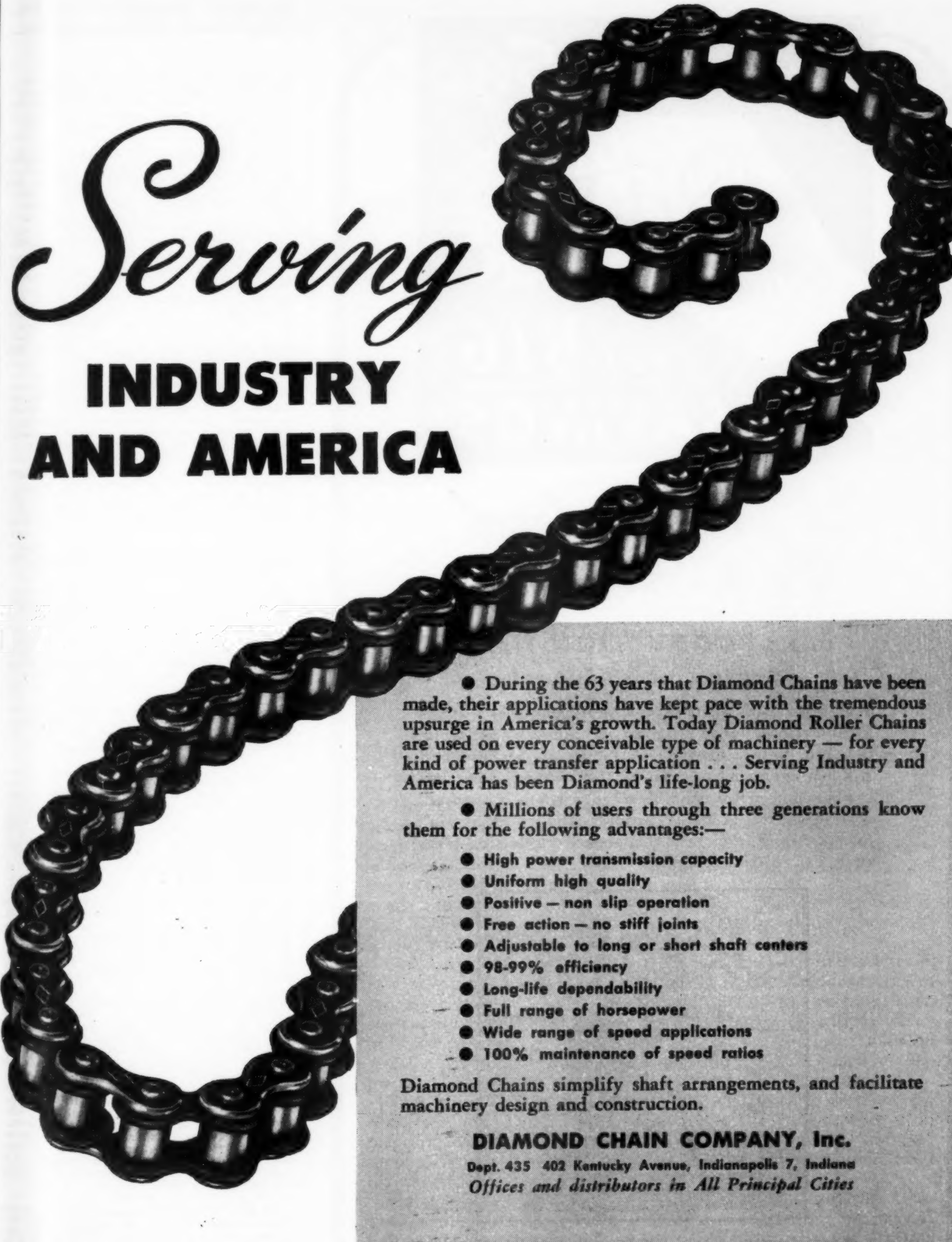

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evaluating the polish on a flat metal surface by a single reading. It will give a quantitative comparison of different surfaces in line with the results of visual examination. Suitability for electropolished surfaces. (ASM)

6-49. "Comparison of the Most Important Methods for Surface-Finish Control"—G. Michalet; *Journees des Etats de Surface,* 1946, pp. 124-134; discussion, p. 134. Different methods and equipment used for the determination of the roughness of surface and degree of polishing. Schematic drawings of equipment; methods of their application. 17 references. (ASM)

7-49. "Taper Sectioning"—E. Rabinowicz; *Metal Industry,* v. 76, n. 5, February 3, 1950, pp. 83-86. Cutting of section at small angle to surface for study of surface finish; methods of sectioning; use of taper sectioning in study of surfaces after sliding; effect of sliding small metal hemisphere on flat surface under load illustrated. Bibliography. (EI)

8-49. "Improved Surface Finish Increases Tool Life"—Thomas Badger; *American Machinist,* v. 93, February 24, 1949, p. 86. Experimental data. Surface-finish improvement from 30 to 5 microinches resulted in tool-life increases of 90 to 152 per cent. (ASM)

9-49. "Methode d'etude des Granulations Visibles a la Surface des Metaux Soumis a des Deformations Plastiques"—J. Herrenguel and M. Scheidecker; *Revue de Metallurgie,* v. 46, n. 8, August 1949, pp. 537-543. Study of visible granulations on surface of metals subjected to plastic deformations; granulations by corrosion patterns and slip lines; interpretation of slip lines. (EI)

10-49. "Determining the Degree of Roughness with Aid of a Flat-Grinding Process"—H. Klemm; *Archiv fur Metallkunde,* v. 2, February 1948, pp. 46-49. The process is characterized by the fact that a plane is ground at a given angle to the surface to be investigated. The consequent enlargement of roughness depends on the angle of the "grind" to the investigated surface. (ASM)

11-49. "GM and Chrysler Researchers Produce New Roughness Gage Blocks for Machined Surfaces"—W. G. Patton; *Iron Age,* v. 163, March 17, 1949, p. 106. (IAI)

12-49. "Application of Pneumatic Method for Evaluation of the Quality of Surface Finishes" (In Russian)—M. L. Brzhezinskii; *Stanki i Instrument* (Machine Tools and Instruments), v. 20, March 1949, pp. 20-22. "Pneumatic profilograph" with automatic recording. It consists, essentially, of a hydraulic pressure regulator, a pneumatic chamber, a recording manometer, and a measuring attachment. (ASM)

13-49. "Appreciation of Various States of Surface by Method of Total Reflection"—A. DeGramont; *Microtecnic* v. 3, May-June, 1949, pp. 118-120. Method consists essentially of defining ratio between "carrying surface" and total surface of metal sample; description of procedure and of "surfascope". (EI)

14-49. "The Characteristics of Machined Surfaces"—A. J. Chisholm; *Machinery* (London), v. 74, June 2, 1949, pp. 729-736. Factors affecting the roughness of cut surfaces produced by simple edge-cutting tools. Lubrication surface deformation, and residual surface stresses. (ASM)

15-49. "'Talysurf' Surface-Measuring Instruments"—*Engineering,* v. 167, n. 4349, June 3, 1949, p. 523. Instruments manufactured by Taylor, Taylor, and Hobson for determining roughness of surfaces such as bearings by traversing a sharply pointed stylus over them and then electrically amplifying its movements. (EI)

16-49. "Ueber Rauhigkeitsmessung mit dem Elektronenmikroskop"—R. Seeliger; *Zeit fuer Metallkunde,* v. 39, n. 6, June 1948, pp. 170-172. See also brief English abstract in *Engineer's Digest,* v. 10, n. 5, May 1949, p. 176. Measurement of surface roughness with electron microscopes; presentation of surfaces can be effected by thin transparent detachable layers (oxides, lacquers, quartz or metal evaporation) deposited on surface, or by matrix technique; production of stereoscopic pictures, from which distance of corresponding points can be measured and depth measurements plotted in graph; application of "shadow casting" method to electron microscope. (IAI)

17-49. "New SAE Finish Standard Aims to

Surface Finish

Help Engineer and Shop Man"—*SAE Journal*, v. 57, July 1949, pp. 33-38. The above and its use. The standard is published in the 1949 *SAE Handbook*. (ASM)

18-49. "Technological Precision and Fineness of Machining"—(In Russian)—A. A. Matalin; *Stanki i Instrument* (Machine Tools and Equipment), v. 20, July 1949, pp. 19-22. Analyzes surface-finish standards used by the Bureau of Standards and the USSR Classification according to this standard and its relation to different types of material and methods of machining. (ASM)

19-49. "A New Method for Surface Reproduction"—K. B. Mather; *Metal Progress*, v. 56, August 1949, pp. 225-227. If a reasonably flat metal surface is pressed into a fine-grained photographic emulsion at about 15,000 psi, and the plate developed and examined under a microscope, a pattern is found that reproduces the surface contours. A pronounced three-dimensional appearance results. If standardized, it is believed that the method might give a quantitative measure of surface roughness. (ASM)

20-49. "Der Stand der Normung der Oberflaechenpruefung in Deutschland, USA und England"—J. Perthen; *Werkstattstechnik u Maschinenbau*, v. 39, n. 8, 1949, pp. 252-253. Review of status of standardization of surface testing in Germany, United States and England. (EI)

21-49. "Surface Finish Requirements in Design (abstract)—J. A. Broadston. *Mechanical Engineering*, v. 71, September 1949, p. 755. (IAI)

22-49. "Untersuchungen am Zeiss-Lichschnittgeraet nach Schmaltz"—H. von Weingraber; *Werkstattstechnik u Maschinenbau*, v. 39, n. 9, 1949, pp. 268-274. Report of investigations with Schmaltz-Zeiss microscope for precision surface testing. (EI)

23-49. "New Surface Measuring Instrument"—H. Benning-Hoff; *Industrial Diamond Review*, v. 9, n. 106, September 1949, pp. 261-262. Tracer point instrument developed in Germany by Forster during war; surfaces of 100 mm width can be tested with error of less than ± 0.2-micron; device is provided with interchangeable measuring tubes; testing limits are 100 microns and 0.1-micron. English translation from *Archiv fuer Oberflaechentechnik*. (EI)

24-49. "Effect of Surface Roughness on Rolling Friction"—J. J. Bikerman, *Journal of Applied Physics*, v. 20, n. 10, October 1949, pp. 971-975. Minimum tilt at which bearing balls roll down inclined plate of stainless steel is greater for rough than for smooth surfaces. Roughest surfaces gave almost quantitative agreement between height of elevations and height of hills calculated from theory attributing rolling friction to surface roughness; surface roughness seems to cause rolling friction at low pressures. (EI)

25-49. "Examination of Surfaces"—J. W. Sawyer, *Journal of the American Society of Naval Engineers*, v. 61, n. 4, November 1949, pp. 819-827. Permanent and accurate three-dimensional records of surface finish and damage can be made. Record made by casting onto surface a resin which hardens in about 20 minutes after addition of catalyst; resin and catalyst are preweighed and packaged ready for immediate use. External heat and pressure not required. After resin hardens casting is removed for study; negative replica may be tested with profilometer or similar surface measuring instrument without damage to casting. (EI)

26-49. "A New Concept of Surface Measurement. Present Methods of Surface Finish Control and Development of Geometric Surface Finish Standards"—Arthur F. Underwood and Roy P. Trowbridge. Development of ruled surface-finish standard by General Motors Corp. Originals are made on 2 by 3-inch blocks of silver-clad steel plates with gold. The surface is polished to an average roughness of one microinch. Rulings are made on a special machine with a diamond stylus. Duplicates are made by an electroforming process. Method of calibration and use of Nelson's taper sectioning method which increases magnification in one direction by as much as 25 to 1. (ASM)

27-49. "Surface Roughness of Metals"—T. P. May and R. L. Burrell Jr., *Steel*, v. 125, November 21, 1949, p. 118. Abstract of paper on gas adsorption method for determining roughness of metal surfaces. (IAI)

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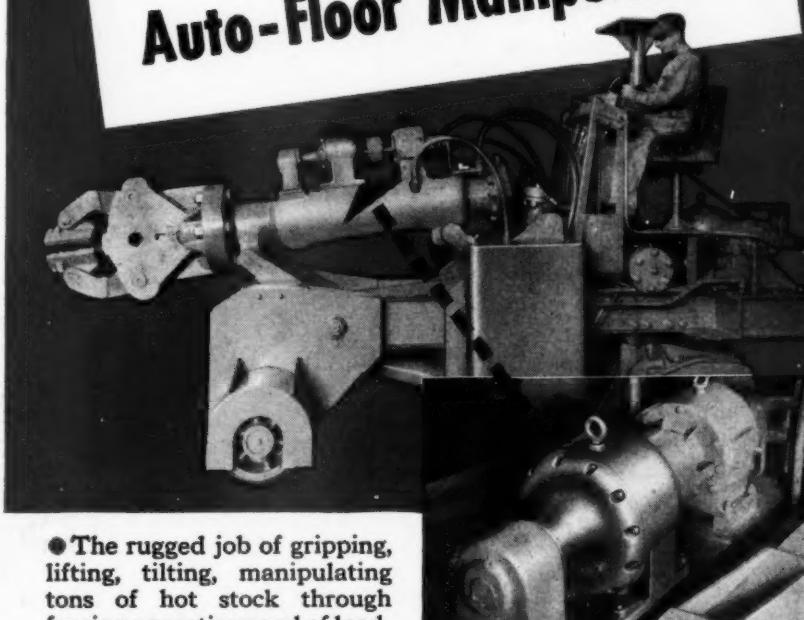

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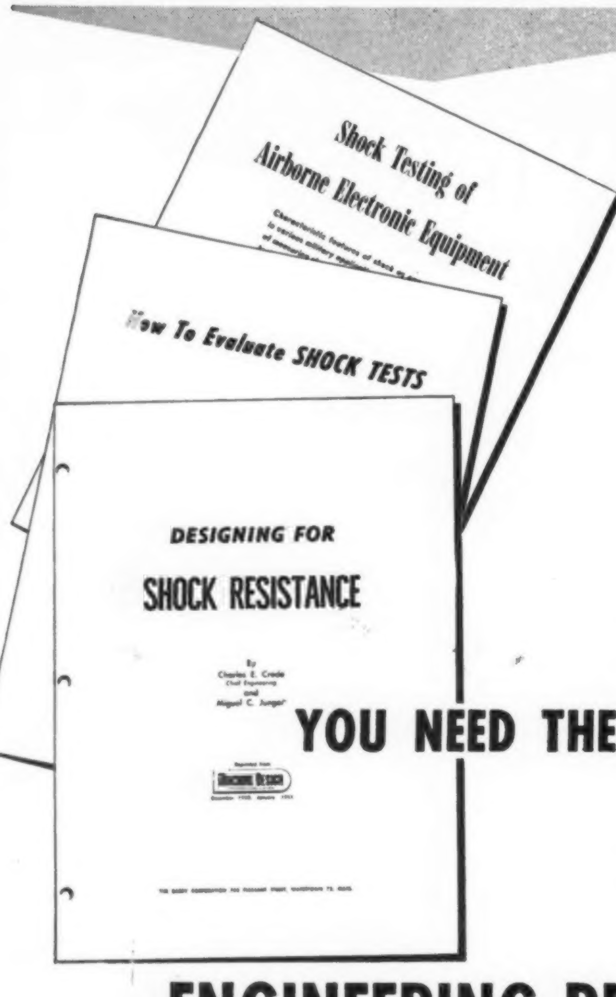

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Roughness Standards"—C. R. Lewis; *The Tool Engineer*, v. 23, November 1949, pp. 22-24 (IAI)

29-49. *Prufefen and Messen der Oberflaechengestalt*—J. Perthen, Carl Hanser Verlag, Munich, Germany, 1949, 257 pages. Volume three of series on technical measurements deals with surface conditions, with methods and apparatus for testing and measuring surfaces, with practical application of surface measurement and its relation to interchangeable manufacturing. Bibliography. Engineering Societies Library, New York. (EI)

1948

1-48. "Plastic Replicas for Surface-Finish Measurement"—J. Pearson and M. R. Hopkins; *Journal of the Iron and Steel Institute*, v. 158, January 1948, p. 138. The methods hitherto described are said to be unsuitable for roughness measurements by stylus instruments. The technique outlined is of more general applicability, as it requires no heating and can be used to make negative surface replicas from objects of any size, roughness, or location. (ASM)

2-48. "Roughness of Surfaces"—W. A. Tuplin; *British Science News*, v. 1, 1948, pp. 18-20. Measuring the roughness of surfaces by use of a stylus which traverses the work. (ASM)

3-48. "American Standard on Surface Roughness" (symposium of three articles); "Why Surface Roughness Standard?"—R. F. Gagg; "What Standard on Surface Roughness Covers"—E. R. Boynton; "One Company's Analysis of Why and How to Use Surface Roughness Standard"—J. W. Owens; *Industrial Standardization*, v. 19, n. 1, part 1, January-February 1948. pp. 6-13. Symposium of three articles on American Standard B46.1-1947, *Surface Roughness, Waviness and Lay*. (EI)

4-48. "Report of Committee on Standards for Machined Surface Finishes"—Hugh B. Conover; *Iron and Steel Engineer*, v. 25, February 1948, pp. 62-63, 65. Includes AISE Standard No. 3. (ASM)

5-48. "Surface Finish"—F. C. Johansen; *Journal of the India Society of Engineers*, v. 13, Feb. 1948, p. 36-40; April 1948, p. 75-80. First installment: methods used to obtain polished or smooth surfaces such as milling, grinding, lapping, electrolytic polishing; methods for determining the conditions of surfaces. Second installment: the various types of surface-finish meters and the physical effects of surface conditions. (ASM)

6-48. "Surface Analysis with Plastic Replicas"—A. J. Chisholm and J. M. Lickley; *Engineering*, v. 165, April 23, 1948, p. 389. (IAI)

7-48. "Proficorder—Instrument for Recording Waviness and Other Surface Profiles"—E. J. Abbott and E. Rupke; *Transactions of the American Society of Mechanical Engineers*, v. 70, n. 4, May 1948, pp. 263-269; Discussion, 269-270. Function of instrument described is to reproduce with appropriate magnifications, actual profile of considerable length of surface; it permits study of individual irregularities as to size, shape, and relative position with respect to other irregularities; instrument can be used to good advantage for inspection of production; setups for waves and other surface characteristics for study of surface finish. (EI)

8-48. *Wear and Surface Finish*—E. L. Hemingway; Gisholt Machine Co., Madison, Wis., 80 pages. The measurement of surface finish, methods of finishing, the reasons for wear and its relation to desirable finish. (From review in *American Machinist*, v. 92, May 6, 1948). (ASM)

9-48. "Plastic Replicas for Surface-Finish Measurement"—J. Pearson and M. R. Hopkins; *Journal of the Iron and Steel Institute*, v. 159, May 1948, pp. 67-70. Methods for producing plastic replicas presented.

10-48. "High Precision Surface Finish Standard to be Offered Metal Processing Industry"—Clayton R. Lewis and Arthur F. Underwood; *Steel*, v. 123, July 19, 1948, pp. 90-92, 124. How the problem of making a master set of standard surface-finish specimens was solved after two years' study by General Motors and Chrysler engineers. Newly designed fine-line ruling machine will rule

Surface Finish

grooves in a polished specimen up to 10,000 lines per inch while holding pitch accurate to ±2 per cent. (ASM)

11-48. "Measuring Roughness With the Electron Microscope"—Robert Seeliger; *Zeitschrift fur Metallkunde*, v. 39, June 1948, pp. 170-172. Method and its basic principles. Irregularities of 100 micron or less can be accurately measured. (ASM)

12-48. "O.P.L. Direct-Vision Surfascope"—*Engineers' Digest* (British Edition), v. 9, n. 7, July 1948, p. 239. Illustrated description of instrument developed by Society d'Optique et Precision of Levallois, for measurement of surface roughness of metal specimens; based on "extinguished total reflection" method, suggested by Golliet, Grunwald and Levy. English abstract from *Measures and Control Industriel*, v. 13, n. 130, March 1948, pp. 99-101. (EI)

13-48. "Recent Developments in Surface Measurement"—Allen G. Gray; *Products Finishing*, v. 12, August 1948, pp. 70, 72, 74, 76, 78, 80. Methods and equipment for measuring surface roughness.

14-48. "How to Specify Surface Quality"—J. F. Fischer; *Machinery*, v. 55, n. 1, September 1948, pp. 174-177. Definition of geometrical irregularities of surfaces, as set forth in American Standard B46. 1-1947; recommended method of indicating surface specifications on drawings; typical surface finish samples currently used; method of securing comparison between surfaces; importance of grinding and cutting tool conditions and their effect on qualities obtained. (EI)

15-48. "Optische Betrachtungen zum Litchschnitternitt-verfahren fuel die Oberflaechenpruefung"—K. Raentsch; *Werkstattstechnik und Werksleiter*, v. 35, n. 18, September 15, 1941, pp. 309-313. Optical aspects of microscopic light slit method of surface testing, developed by G. Schmaltz; its principle, applications and advantages; diagram; tables and photomicrographs. (EI)

16-48. "How Smooth is Smooth? Specification and Evaluation of Machined Finishes"—Ben C. Brosheer; *American Machinist*, v. 92, September 9, 1948, pp. 97-112; September 23, 1948, pp. 111-122. Details of various methods for the above and of the different standard specifications, specimen blocks, and measuring and inspection equipment. Part 2 deals with optical comparators. 113 references. (ASM)

17-48. "The New American Standard on Surface Finish"— George Schlesinger; *Machinery Lloyd* (Overseas Edition), v. 20, September 25, 1948, pp. 91-95. (ASM)

18-48. "The Determination of Flatness of Surfaces and Straightedges; Methods and Instruments Developed at the Rochdale Technical School"—*Machinery* (London), v. 73, September 30, 1948, pp. 497-500. (ASM)

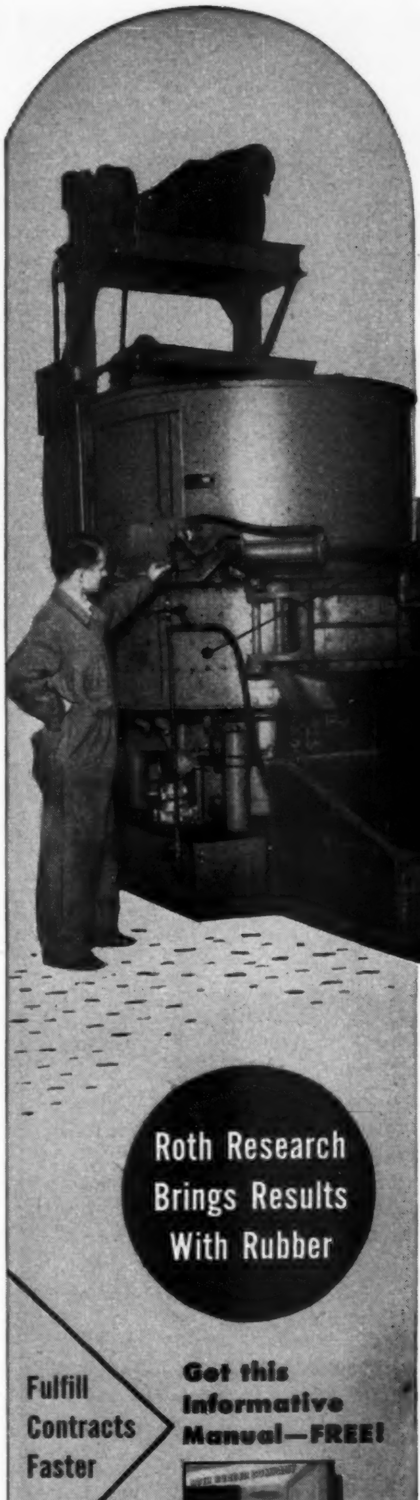
19-48. "Control of the Quality of Surfaces by a Printing Method" (In Russian)—N. M. Ziuskin; v. 13, September 1947, pp. 1143-1145. A system for photographing flaws and irregularities in surfaces, especially in cramped locations, such as inside gun barrels. (ASM)

20-48. "Permissible Limits and Measurement of Roughness of Machined Surfaces"—P. E. Dyachenko; *Engineers' Digest* (British Edition), v. 9, n. 10, October 1948, pp. 340-342. See also *Engineers' Digest* (American Edition), v. 5, n. 8, October 1948, pp. 385-387. When cutting speed and rate of longitudinal feed are changed there is range in which roughness caused by cutting edge changes rapidly; diagrams show limits of various ranges in which roughness characteristics differ from each other. Formulas for determining roughness also given. English abstract from *Stanki i Instrument*, n. 9, 1947, pp. 17-20. (EI)

21-48. "Contemporary Feeler Equipment for Quantitative Determination of Surface Roughness"—P. E. Dyachenko; (In Russian); *Bulletin of the Academy of Sciences of the USSR, Section of Technical Sciences*, October 1948, pp. 1627-1633. Existing methods and apparatus. Comparative results. (ASM)

22-48. "Control of Surface Finish Improves Quality, Cuts Cost"—H. R. Clauser; *Materials and Methods*, v. 28, October 1948, pp. 74-77. Significance of roughness, waviness, and lay or scratch pattern and methods for their measurement. How surface-finish control improves quality and cuts costs. (ASM)

23-48. "Seek Ways to Control Surface



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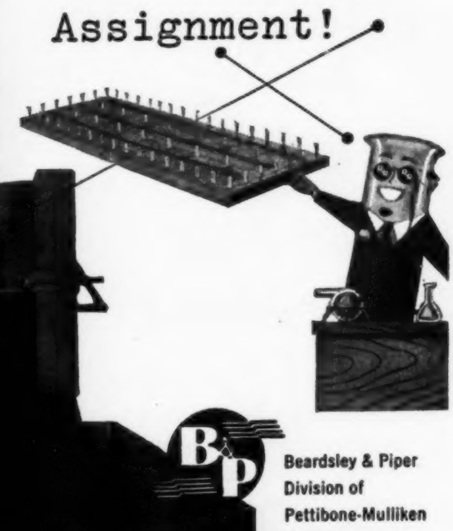

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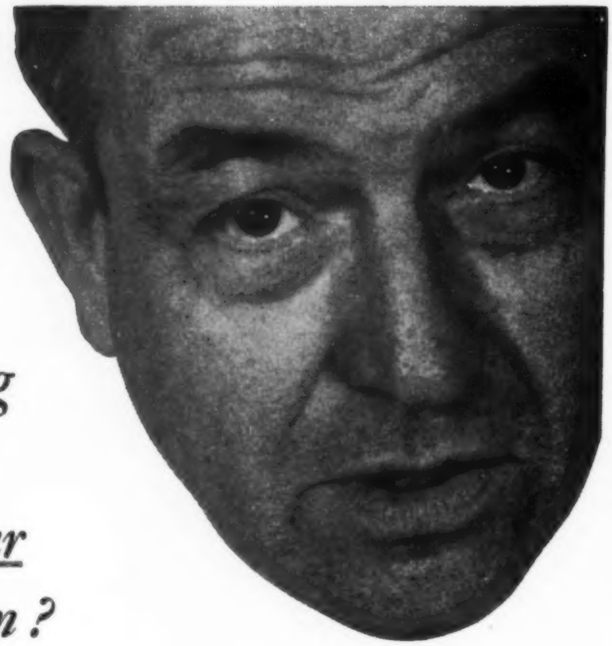

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Surface Finish

Finish Quality," based on "The Present Status of Surface Finish Control"—C. R. Lewis; *SAE Journal*, v. 56, October 1948, pp. 92-93. Problems involved in establishment of criteria of surface-finish quality, including both roughness and character, and in development of standards providing a common reference point for work in this field. (ASM)

24-48. "Controlling Surface Finish to Specified Quality Standards"—Roger F. Waindle; *Tool and Die Journal*, v. 14, October 1948, pp. 66-70. Methods used by Elgin National Watch Co. (ASM)

25-48. "Some Applications of Plastic Replica Process to Surface Finish Measurement"—C. Timms and C. A. Scoles; *Machinery*, (London), v. 73, n. 1887, December 23, 1948, pp. 871-875. Suitability of technique for measurement of finish of large engineering components, such as marine gear teeth and flanks of master lead screws, which are not readily accessible with standard instruments; plastics replica of machined surface is made on strip or film of cellulose acetate, impression thus obtained being measured directly by means of stylus recording instrument; application to flat and curved surfaces; accuracy discussed. (EI)

26-48. "Designating Surface Roughness with Aid of Geometric Standards"—C. R. Lewis and A. F. Underwood; MACHINE DESIGN, v. 20, n. 12, December 1948, pp. 137-140. General Motors Corp. and Chrysler Corp. Project which involved production of master set of standard surface finish specimens from which exact replicas could be made; final plan entailed making master specimens by ruling geometric pattern on flat polished gold plates with diamond stylus. Manner of making replicas proposed surface finish standard; symbols and surface finish specifications; definitions used. (EI)

27-48 "Refined Surface Finishes" — W. Johnson; *Iron and Coal Trades Review*, v. 157, n. 4216, December 31, 1948, pp. 1485-1487. Interpretation of surface roughness readings; some of methods, processes, and equipment used to produce superfine finishes; description of effect of surface roughness readings on performance of journal bearings also dealt with; special reference to various components in steel plant equipment. Before International Congress of Mechnical Engineering, Paris, September 1948. (EI)

Next month a review of surface finish literature published from 1945 to 1947 will be presented. A cross-reference subject index of all abstracts will appear in the November issue.

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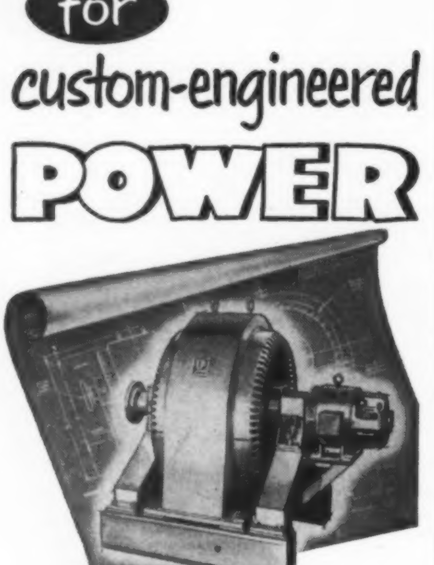

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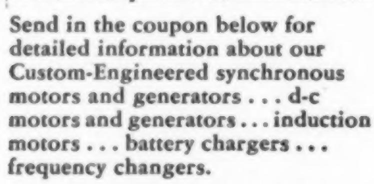

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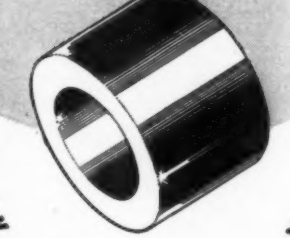

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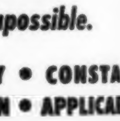

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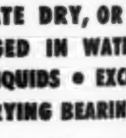

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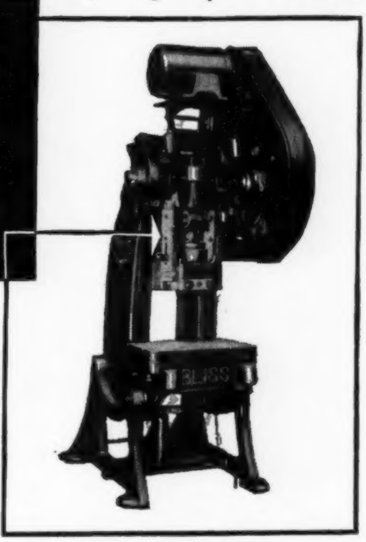

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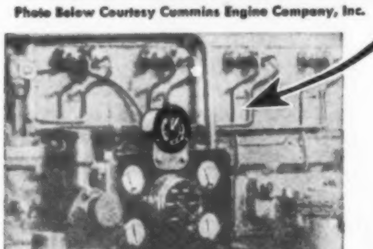

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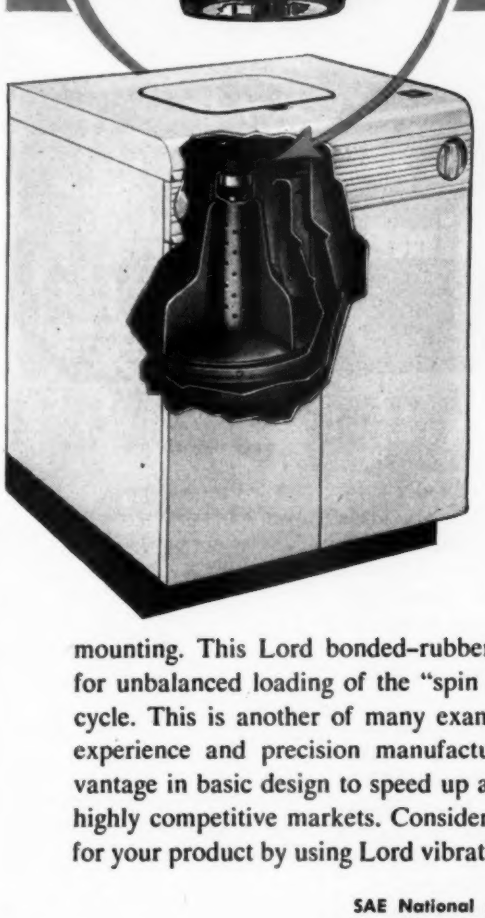

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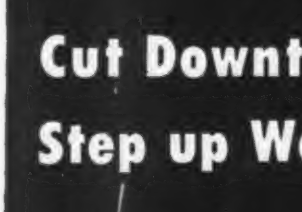

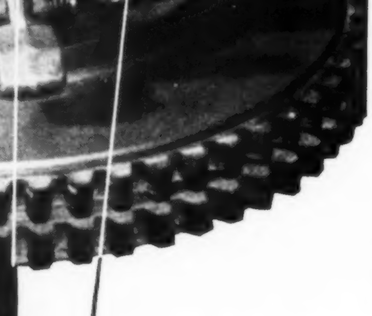

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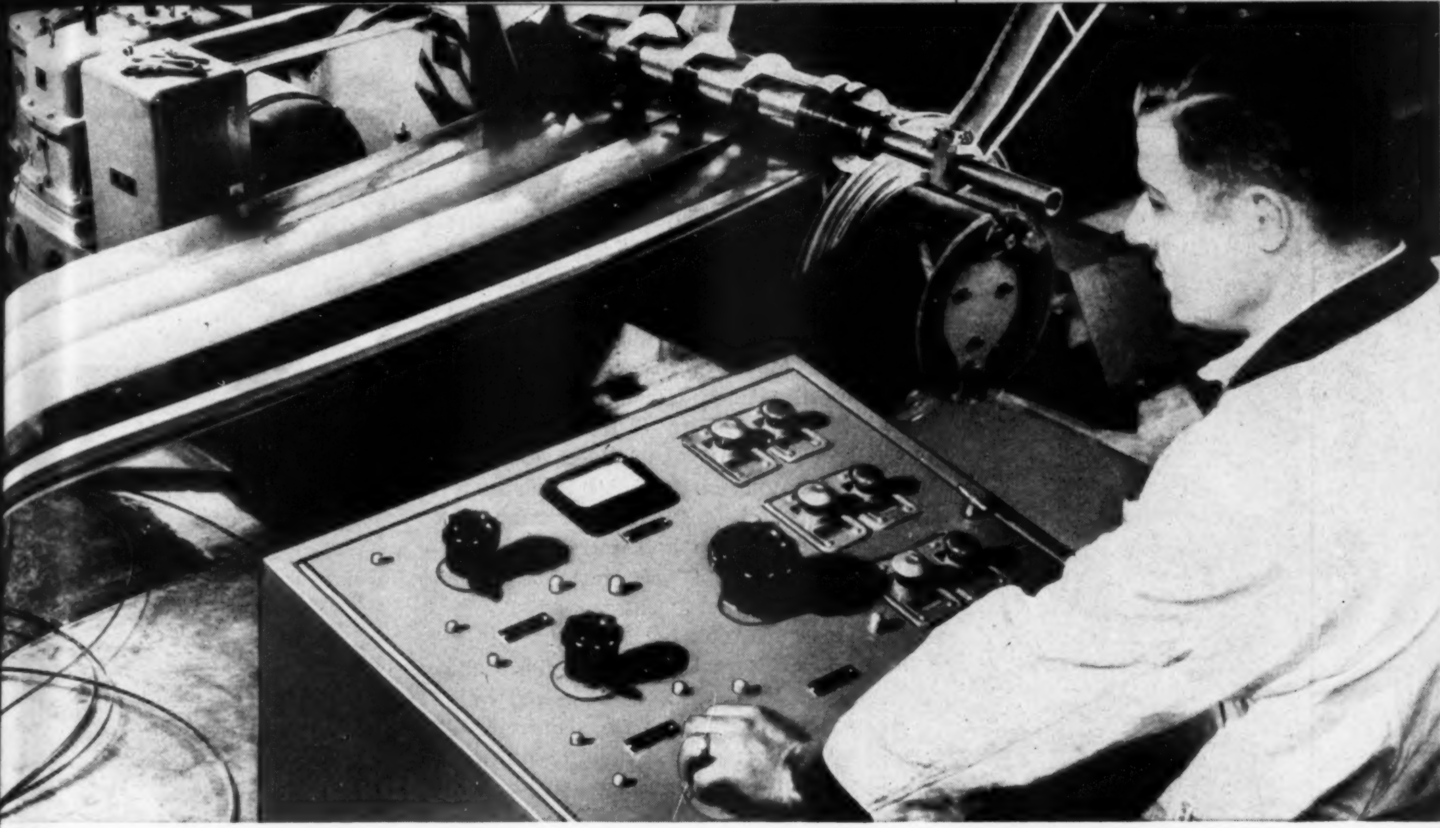
12.53 pitch aircraft zerol bevel reduction gear in 30 seconds' cutting time. Work is brought into cutting position by pneumatic cylinder. Teeth are then chamfered by rotating work in timed relation to cutting action of four dovetail high-speed steel form tools. When cutting cycle is completed, work is automatically lowered into unloading position. Floor space required, 28 by 40 in.; overall height, 70 in.; weight, 2200 lb. *Modern Industrial Engineering Co., Detroit, Mich.*

Platen Presses: More than 200 models with capacities ranging from 10 to 500 tons. Available with square or rectangular platens, up-acting, down-acting, 90-degree angle transfer frame and top transfer. Multiple platens available for rubber and plastic molding, laminating, metal forming and shaping, die tryouts and utility applications. Allow maximum deflection of 0.0005-in. per inch of span on each of the work platens when full rated load is applied uniformly over entire working area. Heavier construction can be supplied for work requiring less than 0.0005-in. deflection. Hand or power-operated pumps, single or double-acting cylinders available. *Rodgers Hydraulic Inc., Minneapolis, Minn.*

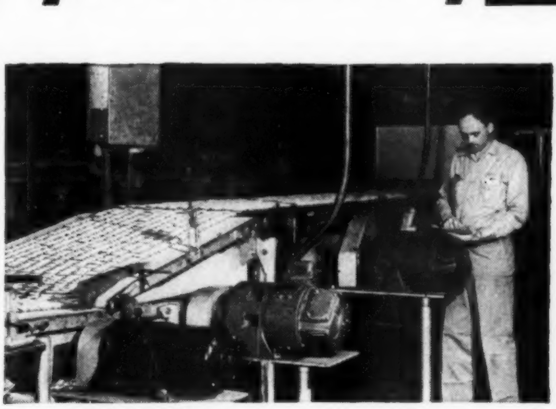
Squaring Shear: Can cut 24-ft widths of ¼-in. mild steel plate. Cutting cycle is 20 strokes per minute. Hydraulic holddowns exert over 22 tons pressure. Has 24-in. throat or gap, 48-in. back gage range, light beam shearing gage, and an air-controlled clutch operable from either of two foot valves. *The Cincinnati Shaper Co., Cincinnati, O.*

Gear Hobber: Model 1458-A Ultra-Speed machine. Will hob teeth on two 3⅛-in. diameter helical gears with a 1⅝ in. total face width in 58 seconds. Operates automatically after start button is depressed. Tailstock center moves into place under hydraulic pressure; hob and work spindles start rotating and hob-spindle column moves forward horizontally to plunge-feed hob into work. When proper depth has been reached, feed stops, and work immediately starts to traverse across hob. After end of the work



G-E SPEED VARIATORS, operated by central control panel (above) were chosen by E. F. Hauserman Co. of Cleveland, Ohio for its steel slitting operation. General Electric Speed Variators provide flexible performance in the 1–200-hp range at moderate cost. For even greater accuracy and versatility in automatic operation, these drives may include amplidyne or electronic regulators.

These G-E Adjustable-speed Drives can help you boost *your* output, too!



G-E THY-MO-TROL* drives assure the Keebler Weyl Baking Co. of Philadelphia of proper baking for many different products. This electronic control is particularly suited for precise adjustable speed in 1/4 to 10-hp drives—offers speed ranges to 100:1 and more.

◀**G-E ACA MOTORS** give the Ford Motor Company a simple, compact, and lowest-cost method of controlling pump speeds at its oxygen generating plant, leased from Air Products Inc. This adjustable-speed motor requires no conversion equipment—an a-c induction motor with stepless speed adjustment by a simple twist of a dial.

*Reg. trade-mark of General Electric Co.

GENERAL ELECTRIC

WHICH G-E DRIVES ARE BEST FOR YOU?

Because only General Electric makes *all major types* of electric adjustable-speed drives, it is best qualified to help you select the *right drive*. Send for these informative bulletins.

☐ A This 26-page manual describes *all* four types of drives and where to apply them. Bulletin GEA-5334.

☐ B Lower cost, simplest a-c drive Bulletin GEA-4883.

☐ C More flexibility, moderate cost. Bulletin GEA-5335.

☐ D Top performance, ¼-10 hp Bulletin GEA-5337.

☐ E Top performance, 1-200 hp Bulletin GEA-5336.

General Electric Company,
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☐ for planning an immediate project

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Made from Promet No. 6, an outstanding leaded bearing bronze noted for its free machining properties. Unbelievably great resistance to heat and wear. Will not burn, seize, pound out.

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Tougher, harder and stronger, it resists shock loads and withstands high compressive forces and will not cut, or stick to the shaft under ordinary operating conditions. There is no seizing, no scoring—just smooth, quiet operation. Will not powder under the most severe conditions of service. When lubrication fails temporarily, Promet carries on safely until proper lubrication can be restored, affording protection against production shutdowns.

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Completely precision machined inside, outside and on the ends, yet sufficient stock remains for the finishing cut. Can be machined at speeds of more than 500 feet per minute—more than double those of phosphor bronzes. This complete machining insures you against subsurface defects sometimes found in rough cast bars. A considerable amount of metal has already been removed—metal which you would be purchasing if you used rough bars. Every bar is absolutely concentric.

Available round, hexagon and square, in 13-inch lengths, rough cast.

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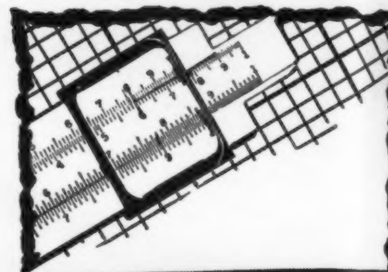
New Machines

has passed centerline of hob, the hob spindle retracts from the cut and the work returns to loading position. Spindle rotation stops and tailstock center also retracts for removal of workpiece. Capacity specifications: Recommended gear diameters, 1 to 8 in.; maximum face width recommended, 4¾ in.; maximum hob diameter 7 in.; maximum hob length, 7 in.; center distance between hob and work spindles, 2 3/16 to 7½ in.; maximum work length recommended, 25 in. (gear cannot be less than 2 in. from one end); maximum spindle speed, 1000 rpm. Feed is infinitely variable. Floor space required, 84 by 84 in.; overall height, approximately 8 ft. including hob shifter; approximate weight, 18,000 lb. *Michigan Tool Co., Detroit, Mich.*

Automatic Molder: Model 2160-C for high production of uniform standard molds. Pushbutton type electrical controls for either fully automatic or selective manual control. Once machine is set up, operation of two buttons actuates complete molding cycle. Operations are automatically controlled by solenoid valves. Jolting action is timer controlled; squeeze is regulated by a pressure switch. Stripping pins adjust to accommodate a range of flask sizes. Squeeze capacity, 1600 lb; jolt capacity, 1500 lb on standard 80 psi line pressure; pattern draw, 10 in; maximum squeeze stroke, 12 in. Flask space ranges from 19 to 31 in., left to right, and from 16 to 31 in., front to back. *SPO Inc., Cleveland, O.*

Spot Welder-Solderer: Spot welds steel parts up to 3/16-in. in thickness; copper to bronze, copper to copper up to 0.040-in. in thickness and brass to brass up to 0.080-in. in thickness. Solders brass up to ¼-in. in thickness, as well as sterling silver and other precious metals. Features quick-adjusting device for pressure control and length of electrode travel for positive soldering and welding. Electrodes are especially designed for each job. Their operation is spring-action controlled so that, when the electrode arms are closed, work is held firmly in position during soldering and cooling. Automatic



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National Retaining Rings

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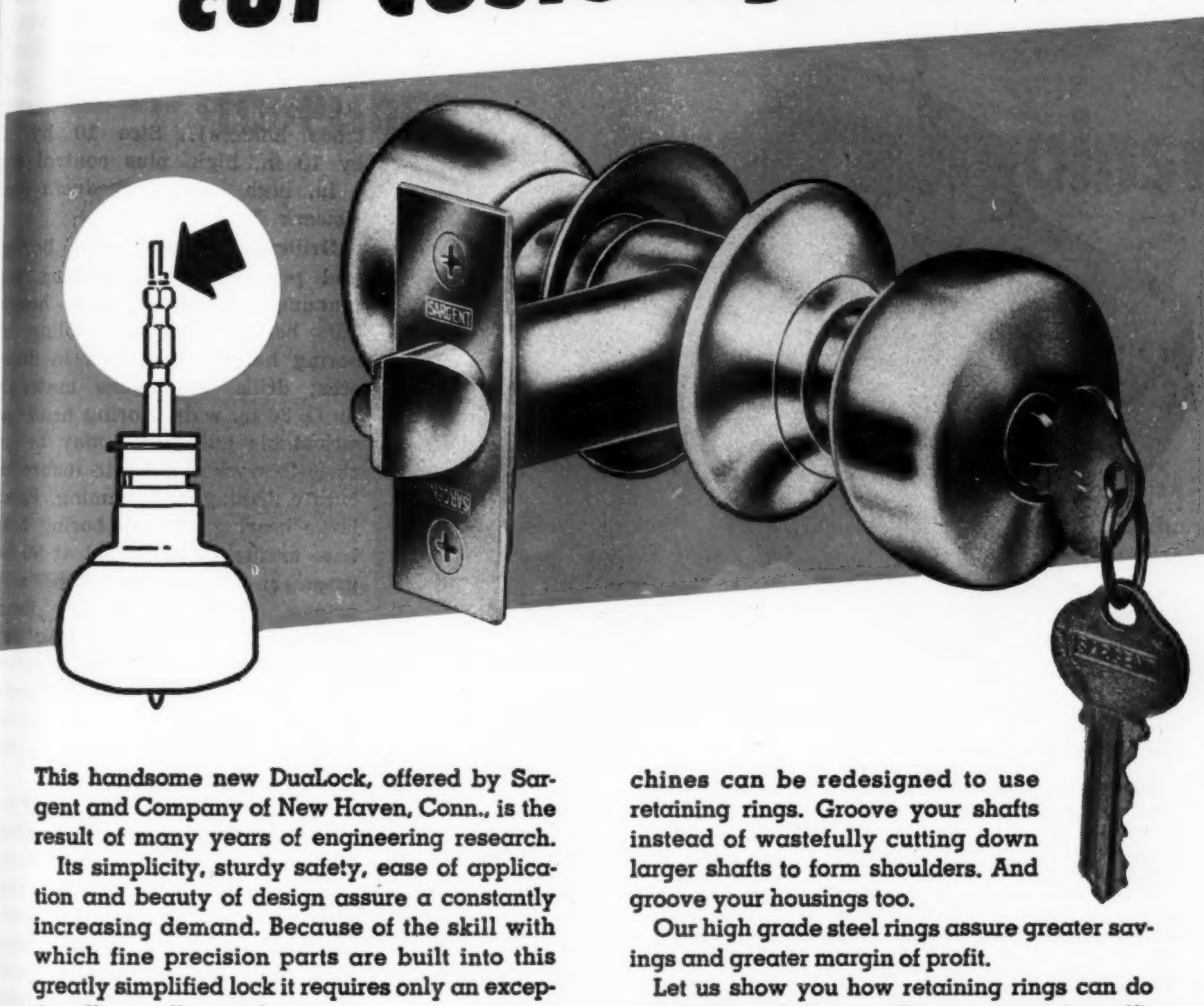

This handsome new DuaLock, offered by Sargent and Company of New Haven, Conn., is the result of many years of engineering research.

Its simplicity, sturdy safety, ease of application and beauty of design assure a constantly increasing demand. Because of the skill with which fine precision parts are built into this greatly simplified lock it requires only an exceptionally small cross bore.

By using National retaining rings Sargent saves material, weight, space and assembly time—without sacrificing efficiency or strength.

Examine your products—metal, wooden or plastic. Many products as well as many machines can be redesigned to use retaining rings. Groove your shafts instead of wastefully cutting down larger shafts to form shoulders. And groove your housings too.

Our high grade steel rings assure greater savings and greater margin of profit.

Let us show you how retaining rings can do an efficient job for you. These inexpensive, efficient artificial shoulders save time, save weight, save space, save materials, save money.

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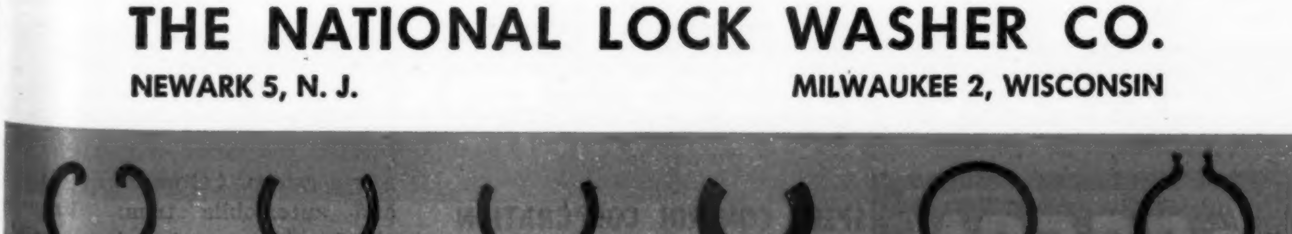
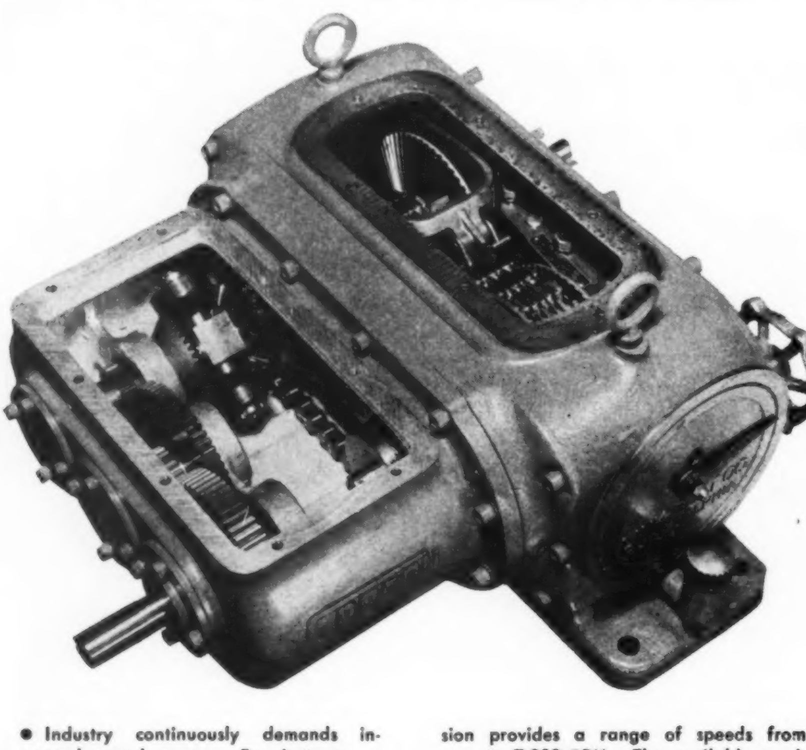


SPEED CONTROL **NEWS** . . . *of interest to machine designers and plant engineers*

SPECON MD TRANSMISSIONS

provide controlled speed over infinite speed range



• Industry continuously demands increased speed range. For instance, a machine that makes non-metallic washers. They have a limited speed range if washers are approximately of the same size. If a manufacturer wants to make all sizes of washers on the same machine, he will require an infinite speed range. It is desired that machines be able to produce as great a variety of products as possible. In all these cases the MD Transmissions will provide the best drive.

To overcome this and similar problems created by modern methods, the Specon MD Transmission was developed. This is a positive mechanical drive with no belts and no slippage.

Another unusual and valuable fecture of the Specon MD Transmission is its compactness. As a rule the greater the speed range, the larger is the over-all size of the conventional transmission. The combination of infinite range and compactness in the Specon MD Transmission are two of its outstanding features.

Speed control of the Specon MD Transmission may be manually or remotely adjusted from zero with infinitely small steps to the maximum rated speed. For example, Specon #1 MDY 13 Transmission provides a range of speeds from zero to 7,000 RPM. The available maximum output speeds range from 7,000 to 160 RPM. The zero speed of course is available with all units.

Two designs are available. Under certain circumstances the application load may require high torque at low or zero speeds. With these conditions the Specon MDY Transmissions with 200% torque at zero speed is available in output capacity to 10 HP. Other applications will ideally accommodcte the Specon MDX design that provides 50% torque at zero speed. This design is available in capacities up to 20 HP output.

We invite your inqui ies for further information about the Specon MD Transmission.

Speed Control Corporation also manufactures electrical drives known as Specon ED Drives. By means of the proper control ED Drives can provide accurate adjustable speeds comparable to speeds obtained from Specon MD Transmissions, or soft speeds automatically adjusted to proper tension requirements, or provide performances demanding acceleration and deceleration within a fraction of a second, or demanding accurate synchronizetion of number of speeds, etc. There is no such thing as a difficult problem for Specon Drives.

SPECON

SPEED CONTROL CORPORATION

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New Machines

cut-off timer regulates soldering time. Heat control has 11 adjustments. Three models available with the following power requirements: Model 1000 WV—110-v ac, 9 amp; Model 2000 WV—220-v ac, 10 amp (equipped with water-cooled electrode holders); Model 5000 WV—220-v ac, 25 amp (equipped with water-cooled electrode holders). Size 10 by 11 by 10 in. high, plus control box 4 in. high. *Joyal Products Inc., Newark, N. J.*

Drilling Machine: For boring, and precision-layout drilling and reaming. Equipped with heavy-duty boring head and tooling for boring holes up to 5 in. in diameter; drills and reams materials up to 36 in. wide. Boring head has adjustable guide that may be set close to work surface to insure accurate drilling and reaming. Extra large bearing area on boring head base assures cross-travel at 90 degrees on ground ways of solid bridge. Table ways are hand-scraped. Two-speed gearing provides rapid traverse for positioning. Two built-in vernier scales aid in locating the work within 0.0001-in. *Wales-Strippit Corp., North Tonawanda, N. Y.*

Bending Machine: Di-Acro Bender No. 4 is hand operated; bends up to 1-in. diameter cold-finished steel bar and 1¼-in. tubing or their equivalents. Designed for heavy bending operations where production does not warrant a power driven machine. Radius bending range is from 0 to 12 in. Features built-in ratchet mechanism which can be engaged or disengaged by operator, depending upon size of material being formed. Engaging the ratchet mechanism increases the bender capacity for larger and heavier materials. Direct drive makes possible greater production in light materials. *O'Neil-Irwin Mfg. Co., Lake City, Minn.*

Surface Finishing Machine: Model 203-A for surface finishing formed decorative nameplates for refrigerators, stoves, appliances and automobile trim. Vacuum chuck arrangement makes possible the handling of brass, copper, silver, plastic, aluminum, wood and

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FLEXIBLE COUPLINGS

provide for AND protect against misalignment

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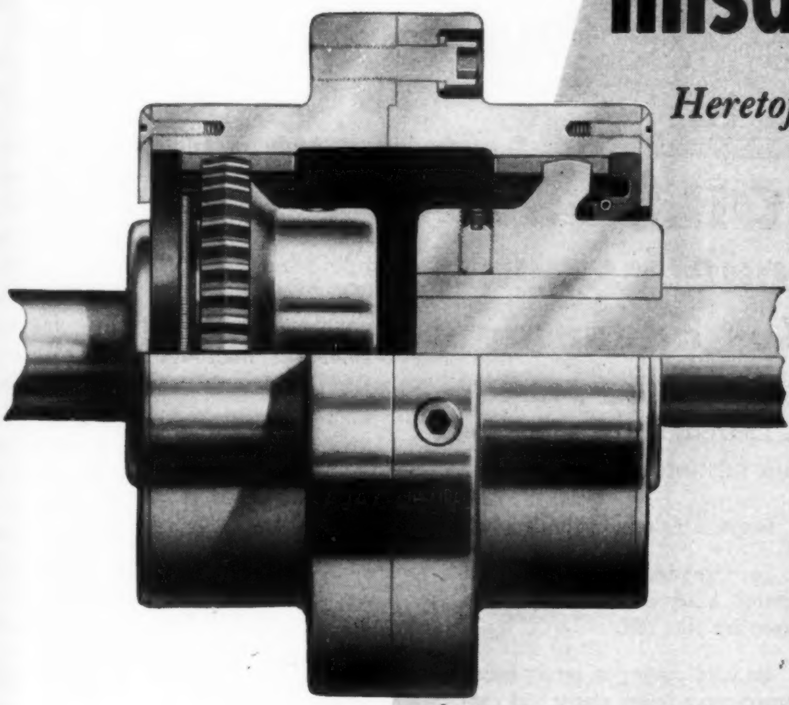

Ajax Dihedral surfaces of gears provide maximum bearing area and do not tend to rupture the oil film. This contributes to long life, cool running and quiet, chatter-free operation.

All gear teeth hardened to 50 to 55 Rockwell C.

* The performance of Ajax Dihedral Couplings confirms the fact that *there is no competition with quality.*

Design, installation and maintenance men are saving thousands of hours, and dollars by eliminating necessity for precision alignment of direct-connected machines.

New and exclusive Ajax Dihedral tooth shape provides for extreme misalignment with tooth clearance (backlash) kept to oil film requirements. Long life is assured because more tooth contact is maintained under operating conditions.

Positive oil seals keep lubrication in and dirt out.

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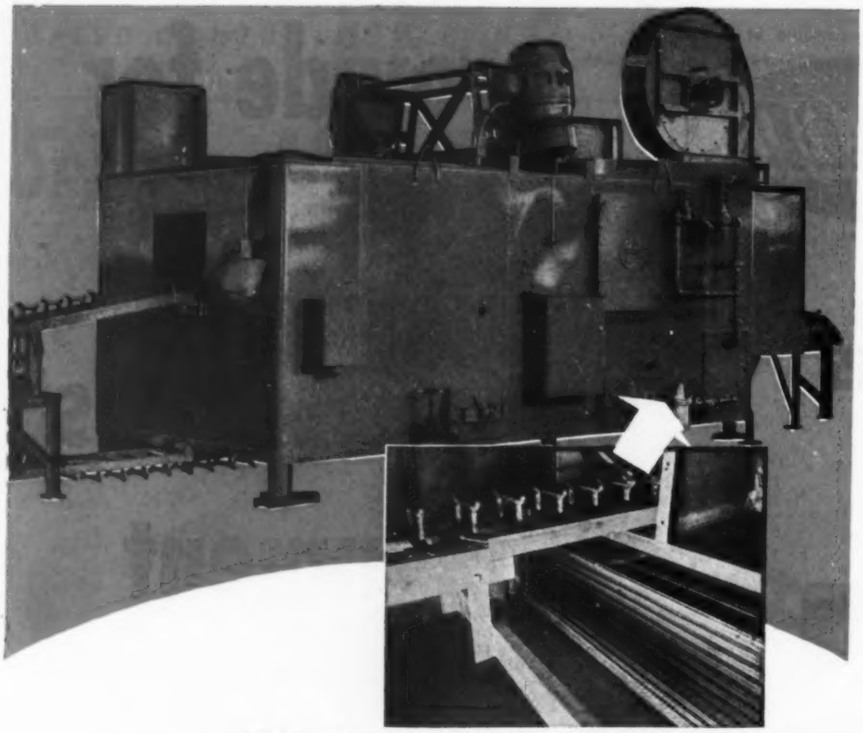
WESTFIELD, NEW YORK



use of PLATECOILS gives CENTRI-SPRAY WASHING MACHINES construction and sales advantages

In building several of these motor block washers for a large automobile manufacturer, Centri-Spray, Inc., Detroit, Michigan has found that the use of Platecoils has 6 important advantages.

1 **Higher heat input per cubic foot for quicker heat-up.**

2 **Easier installation with Platecoil banks.**

3 **At least 90% of threaded pipe joints eliminated to reduce leakage problems.**

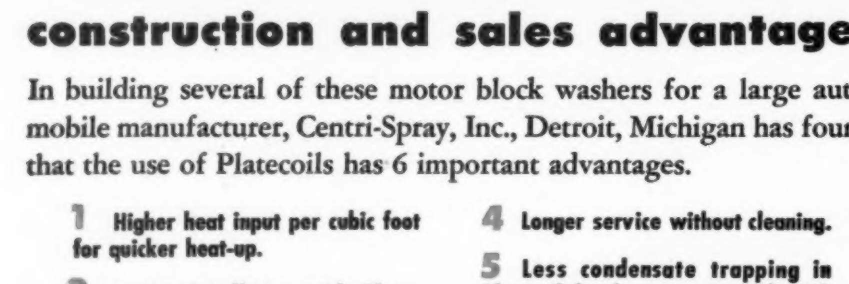
4 **Longer service without cleaning.**

5 **Less condensate trapping in Platecoil bank as compared with serpentine pipe coil.**

6 **No wire cutting in return bends through much lower steam and condensate velocity.**

A bank of three 18 x 83 Platecoils is used instead of a pipe coil consisting of 42 pieces of one inch pipe 85″ long, and two pieces 87″ long. In addition 44 return bends were needed plus the straps and separate tie bars required. Use of the Platecoils not only simplifies fabrication for Centri-Spray, but it also gives their customer a more efficient, dependable washer.

Why not investigate using Platecoils in your products? You will find, as other manufacturers have, that Platecoils save time in estimating . . . that Platecoils save time and labor in fabrication . . . and that customers are better satisfied with Platecoil performance. ***Write today for Bulletin P71.***



New Machines

other nonmagnetic nameplates. All controls are located at a central control panel. Motors available in varying speeds and up to 15 hp. Standard buffs are 9 in. in diameter; also available in 12-in. diameter. Work table is a perforated plate mounted over a sealed air space, connected to a vacuum pump through a four-way spring valve. Standard work table size, 36 in. deep by 38 in. wide; can be built in sizes up to 48 in. by 38 in. Stroke of table is adjustable from ¾-in. to 36 in. in and out; ½ in. to 1¾ in. sideways. *Clair Mfg. Co. Inc., Olean, N. Y.*

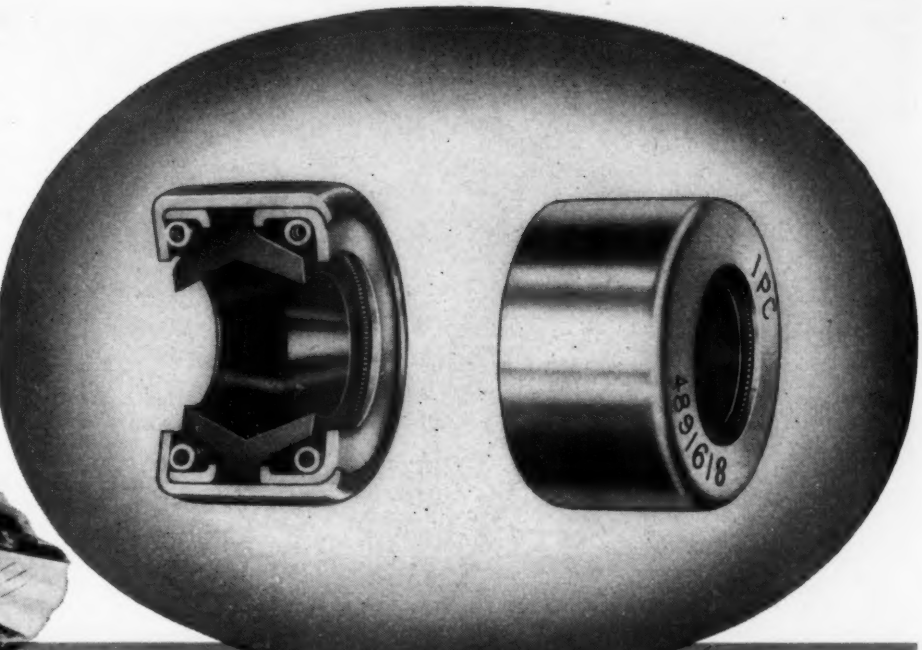
Office Equipment

Telephone Dictation System: PhonAudograph provides economical dictation facilities by connecting several individual dictation telephones with a single recording unit. Each user has a private line connected with recording machine. Features pushbutton control for unlimited listening back; similar control for indicating corrections or special instructions to secretary; private telephone line between dictator and secretary. Amber lights on all phones glow when system is available for use. Fingertip control button on handset is depressed for dictating. "Automatic memory" returns machine to recording position if dictator should hang up after listening to only a portion of the playback. *The Gray Mfg. Co., Hartford, Conn.*

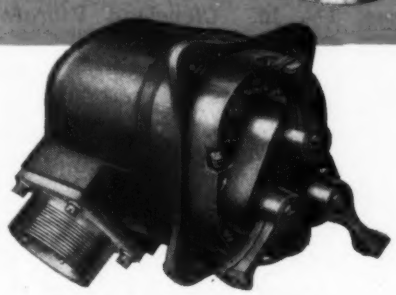
Laminating Press: Sandwiches records, identification photographs, etc., in plastic. Accommodates material up to 5 by 6 in. Complete operation requires two minutes or less. In operation, when plastic reaches proper degree of liquefaction, pressure is applied to cause it to form around and impregnate various elevations or thicknesses of paper. Exerts 4500 lb hydraulic pressure; reaches temperature of 400 F. Operates on 115 v, 60-cycle, 2000-w circuit. *Harco Industries Inc., Rochester, N. Y.*

Folding Machine: Desk model; can fold up to 5000 sheets an hour. Can be set up in about one minute

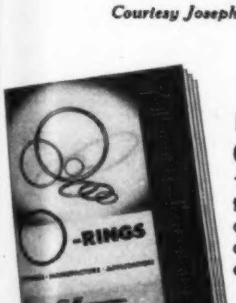
the water has no place to go—<u>but</u> <u>out!</u>



These 3 seals designed and made by G&K-International keep the water out of this electrical throw switch



Courtesy Joseph Pollak Corporation



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As shown in the cut-away view, the sealing elements are synthetic rubber, precision-molded with two balanced lips, each tension tightened by garter springs to insure a uniformly secure grip — and housed in a steel casing. More than 70,000 of these seals have been furnished to this one manufacturer.

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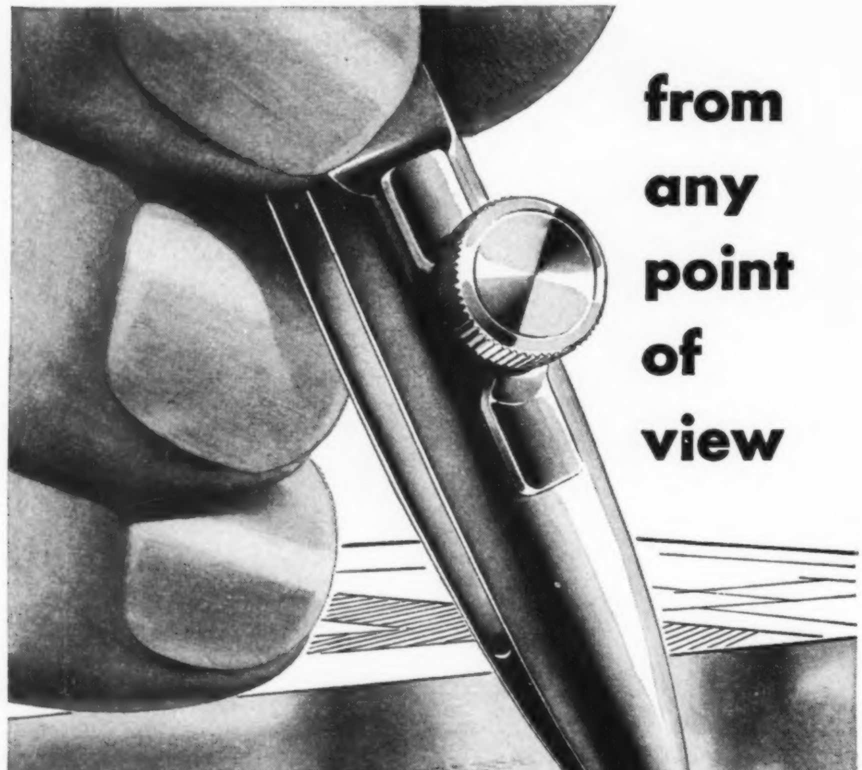

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by means of a measuring rule and the adjustment of two indicator knobs. Feeds and stacks from the same end. Sheets are stacked in hopper and lightly moved by finger to feed rollers from which point operation is automatic. Can make two parallel folds in one operation; makes any one of eight basic types of folds. Handles a variety of paper sizes and weights. Size: 12 in. wide, 7¼ in. high, 22½ in. long, including detachable stacker; weight, 23¾ lb. *Pitney-Bowes Inc., Stamford, Conn.*

Packaging Equipment

Vibrating Table: For packaging small parts and granular material, settling concrete molds, filling containers with semithick liquids, drawing cores, fatigue testing, and other operations requiring platform vibration. Intensity of vibration can be varied by pressure control regulator, permitting operation at 20 to 100 psi line pressure. Table top rests on heavy steel springs. Size: 12 by 18 by 1½ in. *Cleveland Vibrator Co., Cleveland, O.*

Strapping Machine: Produces strap joints by spot welding. Can be installed in standard height conveyor systems. Packages approach machine on a roller conveyor. Roller sections in table top facilitate location of packages over tensioning and welding unit and eliminate the necessity for manual lifting. Fourteen ball-transfer rollers built into table top around strapping mechanism further eliminate handling operations by permitting packages to pass over this mechanism or to be turned for cross-strapping with minimum effort. When package is centered over strapping mechanism operator simultaneously releases required length of strap by deflecting foot pedal and guides strap around package into V-shaped guide slot in table top. Guide slot automatically centers and locates entering strap. When strap is around package, operator actuates cycle bar, causing strap to tighten around package to predetermined tension, and to be cut from the coil and

New Machines

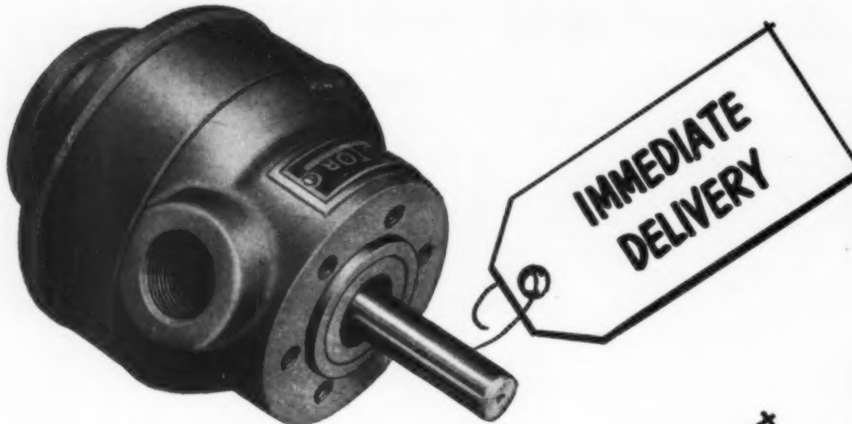
joined by welding. Machine's welding circuit uses 230-v, 60-cycle, single-phase current; control circuit uses 115-v, 60-cycle, single-phase current. Can be furnished to accommodate strap widths of ⅜, ½, ⅝ and ¾ in. and thicknesses up to 0.023 in. Strap tensions up to 750 lb can be obtained. Equipped with counting mechanism. Size: 43⅛ in. wide, 45 in. deep, 47 in. high; weighs 1350 lb. *Acme Steel Co., Chicago, Ill.*

Plant Equipment

Broach Sharpener: For grinding both round and flat broaches. Variable-drive headstock, intermediate steadyrests and live-center tailstock are mounted on a stationary machine bed. Fixed machine bed holds broach rigidly in alignment. Adjustments for sharpening are made with the grinding wheel spindle, which is mounted on a traversing carriage equipped with micrometer adjustment. A 3600 rpm motor drives spindle and has provisions for speeds up to 15,000 rpm. *American Broach and Machine Co., Ann Arbor, Mich.*

Paint and Lacquer Heater: Viscolator, designed to reduce viscosity of lacquer, synthetic enamels and other similar materials. Makes possible the spraying of viscous materials at elevated temperatures. Has vertical straight paint-carrying tubes embedded in solid aluminum as heat transfer medium. Heated by electricity, steam or a combination of both. Available in circulating and noncirculating types in capacities of 12 to 250 gallons per hour. *Arvins Viscolator Corp., Brooklyn, N. Y.*

Dust Collectors: Individual units for use on grinders and other machines where dust must be removed. Have no moving parts; operate from plant air supply; needle-valve control. Quickly cleaned; require no refills. Available in two sizes: 200 series with 24 cu in. capacity for grinding wheels 2 in. diameter or under; 700 series with 56 cu in. capacity for grinding wheels 7 in. diameter or under. *The Vulcan Tool Co., Dayton, O.*



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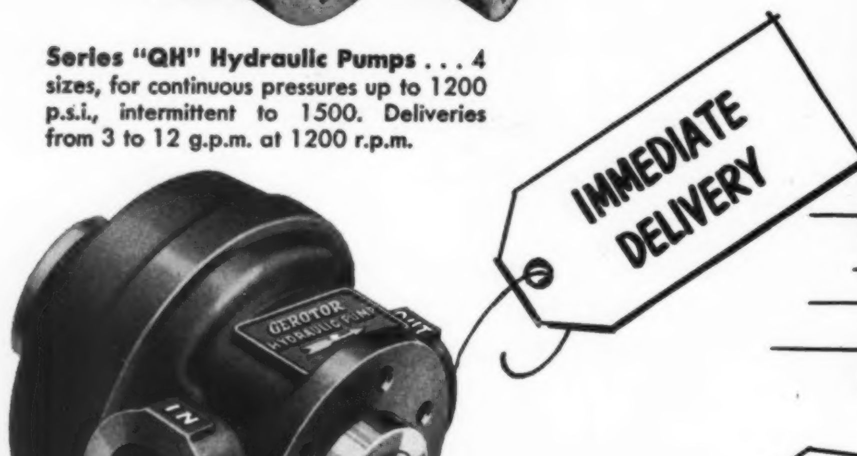

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